Score Cards for Higher Education Institutions

by

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Declaration

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Summary

Performance management and strategic planning are needed for universities to survive and to increase adaptability within their environment. Effective performance measurement enables management to make informed decisions and to improve performance management.

Stellenbosch University recently launched Vision 2040 and the Strategic Framework 2019-2024 with a new set of strategic management indicators. A performance measurement framework placed on the new strategic framework will allow the University to measure progress made on the new strategic framework. Performance refers to effectiveness and efficiency. Effectiveness measured on different levels in the university will allow management to intervene and take corrective actions where needed to steer the university in the direction where the university wants to be in the future.

Literature shows widespread dissatisfaction with most performance measurement systems and many organisations, perhaps the majority, feel that they have not got it right, according to Meyer (as cited in Neely *et al*., 2004:51).

A performance measurement framework was developed for Stellenbosch University to measure effectiveness under the new Strategic Framework 2019-2024. The SU Score Card is based on a composite index approach for effectiveness which is further based on the allocation of weights to performance indicators according to their priorities. Different weights are allocated to core strategic themes, institutional objectives and indicators and measures, which all influence the overall composite effectiveness of the university. Effectiveness and composite effectiveness are both addressed in the SU Score Card model which will assist management in tracking progress made with the goals set for the Strategic Management Framework for Stellenbosch University.

An interactive model was developed for the SU Score Card to visualise the performance for the university. Modelling the performance of the university will assist management to develop a more holistic view of the progress the university is making overall and allow for drill-down to lower levels identifying poor and excellent performance.

Operational level performance indicators that support strategic level performance indicators were identified and modelled to provide management with a line-of-sight of performance across the university from a strategic level to an operational level.

Opsomming

Strategiesebeplanning en effektiwiteitsbestuur is noodsaaklikheid binne universiteite om te bly oorleef en aan te pas by hulle omgewings. Bestuur wat effektiwiteit meet is in 'n beter posisie om ingeligte besluite te neem.

Universiteit Stellenbosch het onlangs Visie 2040 en die nuwe Strategiese Raamwerk 2019-2024 bekend gestel met 'n nuwe stel strategiese bestuursaanwysers. 'n Prestasiebestuur-raamwerk toegepas bo-op die universiteit se strategiese raamwerk wat effektiwiteit meet sal die universiteit in staat stel om hul vordering te meet ten opsigte van die nuwe strategiese raamwerk. Prestasie verwys na effektiwiteit en doeltreffendheid. Effektiwiteit gemeet op verskillende vlakke binne die universiteit sal bestuur in staat stel om in te gryp en korrigerende stappe te neem waar nodig sodat die universiteit in die regte rigting bestuur word waar die universiteit in die toekoms wil wees.

Meyer (soos aangehaal in Neely *et al*., 2004:51) stel dit dat daar 'n wydverspreide ontevredenheid heers onder baie organisasies, moontlik die oorgrotemeerderheid van alle organisasie is ontevrede met die prestasiebestuursraamwerke wat hulle binne hulle organisasie gebruik om vordering mee te meet.

'n Telkaart was ontwikkel vir Universiteit Stellenbosch wat effektiwiteit meet onder die nuwe Strategiese Raamwerk 2019-2024. Die US Telkaart is gebaseer op 'n benadering van 'n saamgestelde indeks vir effektiwiteit wat verder gebaseer is op die toewysing van gewigte, volgens prioriteite, vir alle prestasie-aanwysers in die model. Verskillende gewigte word toegeken aan kern strategiese temas, institusionele doelwitte en strategiese bestuursaanwysers wat die algehele saamgestelde effektiwiteit van die universiteit beïnvloed. Beide effektiwiteit en saamgestelde effektiwiteit word aangespreek in die US Telkaart wat bestuur in staat sal stel om die vordering ten opsigte van die bereiking van doelwitte onder die Strategiese Raamwerk te meet.

'n Interaktiewe model was ontwikkel vir die US Telkaart wat bestuur in staat sal stel om 'n holistiese beeld van die interne prosesse van die universiteit te vorm op 'n oorhoofse vlak sowel as op laer vlakke om uitstekende en swak prestasie te identifiseer. Operasionele prestasie-aanwysers wat strategiese prestasie-aanwysers ondersteun was ook geïdentifiseer en gemodelleer om meer insigte te gee op fakulteit- en departementvlak.

Acknowledgements

I would like to take this opportunity to humbly thank my supervisor, Prof Ian Cloete, without whose guidance and assistance I would never have been able to complete this project.

Secondly, I would like to thank my son and my parents for providing me with unconditional and continued support and seeing me through this process.

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Abbreviations

AHP	Analytical Hierarchy Process
BSC	Balanced Scorecard
CSF	Critical Success Factors
CST	Core Strategic Theme
CUC	Committee of University Chairs in the United Kingdom
EFQM	European Foundation for Quality Management Model
HE	Higher Education
HEI	Higher Education Institution
IG	Division for Information Governance
KPIs	Key Performance Indicators
KRIs	Key Result Indicators
PASS	Professional Administrative Support Services
PIs	Performance Indicators
PMM	Performance Measurement Matrix
PMS	Performance Measurement Systems
PuMP	Performance Measurement Process
RIs	Result Indicators
SMI	Strategic Management Indicator (KPI at Stellenbosch University)
SU	Stellenbosch University
SF	Strategic Framework

Chapter 1

Introduction

Performance refers to effectiveness and efficiency and can only exist if it can be measured or described.

Peter Drucker (1986:36)

1.1. Introduction

Universities find themselves in a world economy with rapid change, intense flow of information and increasing competitiveness. Greater expectations are being placed on higher education, and governments demand increased performance.

Lebas and Euske (as cited in Neely *et al*., 2004:68) define performance as doing today what will lead to measured value outcome in the future. Performance is then the sum of all processes that will lead managers to take appropriate actions in the present that will create a performing organisation that is effective and efficient in the future.

Organisations apply performance measurement frameworks to assist management in measuring performance in organisations. Performance measurement implies the use of performance indicators to measure performance in different areas in the organisation. Performance management aligns performance with strategy.

Performance indicators are found on different levels in the organisation. Strategic level performance indicators measure the organisation's overall performance in strategic areas. Operational level performance indicators supporting strategic level performance indicators measure performance on lower levels in the organisations, e.g. faculty and department levels in universities.

Performance measurement frameworks can also be applied to measure effectiveness in the organisation. Effectiveness implies the extent to which a goal is reached. Calculating the effectiveness of different performance indicators, on different levels can assist management to identify problems, zoom in and drill-down, within the organisation to the area and level where needed, to take corrective action.

1.2. Purpose of this study

Organisations find it difficult to select a performance measurement framework that is suitable for their organisations. Organisations differ in many ways including strategy and purpose, even universities differ in terms of their emphasis on different issues at various times and the challenges and opportunities they face over time.

Stellenbosch University (SU) launched SU's new Vision 2040 and Strategic Framework 2019-2024 on 24 July 2018. (De Villiers, 2018) Vision 2040 and Strategic Framework 2019-2024 is the new "road map" that will guide the University's future positioning, direct the University's strategy and illustrate where and how the University is positioned.

Eckerson (2009:4) describes performance managements as a four-step cycle that involves the creation of strategy and plans, monitor and analyse the execution of those plans and adjust activities and objectives to achieve strategic goals.

The strategic framework for Stellenbosch University for 2019 to 2024 provides a framework for the university to integrate and effectively coordinate the University's institutional strategy, priorities and goals.

An accompanying performance measurement framework will assist in monitoring and analysing the execution of the university's institutional strategy and goals. The framework will also assist in setting priorities aligned with the university's strategy and goals. Operational level performance indicators that support strategic level performance indicators will provide management the opportunity to link activities in the university to the university's strategic goals.

The outcome of this study is a novel performance measurement framework for higher education institutions which can measure overall composite effectiveness for a university, as well as the composite effectiveness on different levels within the university. Priorities can be set by allocating different weights to different performance indicators in the model. Dimensions that are considered more important will be allocated a greater weight and greater organisational effort will be allocated to achieve better performance in these dimensions. Weights allocated to performance indicators have a profound effect on the outcome of the composite index and the change in weights in one or more of the performance indicators in which the organisation excels or fail will have a dramatic effect on the overall score of the organisation.

The study concludes by aligning strategic level performance indicators to operational level performance indicators with a vertical cascading approach. Effectiveness is also demonstrated in this study on an operational level by applying the composite index approach developed to measure effectiveness on a strategic level.

1.3. Research questions

1.3.1. Primary research questions

1.3.1.1. To what extent can a tailored performance measurement framework be developed to measure effectiveness at Stellenbosch University under the new Strategic Framework 2019-2024?

This thesis is primarily concerned with a quantitative analysis and modelling of a performance measurement framework for Stellenbosch University. This study will start by exploring different performance management frameworks in literature. By exploring the advantages and disadvantages and the failures of different performance measurement frameworks, I propose to provide a new, more appropriate approach to measure the University's performance under the new strategic framework for Stellenbosch University.

1.3.1.2. How can strategic level performance indicators be aligned with operational level performance indicators to support the university's goals under the new strategic framework?

Performance indicators are critical ingredients in performance management and should be derived from the institution's goals and should measure progress towards the institution's achievement of these goals. (Kaganski *et al*., 2018 & Eckerson, 2009:9) Performance happens at different levels in the institution and key performance indicators link the institution's vision to individual action.

This study will investigate the possibility to develop an interactive dashboard with performance indicators on an operational level that will support strategic management indicators which should assist management on different levels in the university to take corrective action where needed and steer the university in the implementation of its strategic intent.

1.3.2. Secondary research questions

1.3.2.1. How can existing performance indicators on an operational level within the university be applied to support strategic level performance indicators?

The Division for Research and Development collects data about departments and faculties and then repackage the data as reports to deans in a PDF format. This study will investigate if data collected annually by certain divisions in the university can be incorporated in an interactive model to represent performance indicators on an operational level that will support strategic level performance indicators.

1.3.2.2. How can management track progress made on operational level performance indicators within a university?

Management will have the ability to drill-down in the university from a strategic level to faculty and department level if effectiveness can be calculated on performance indicators on an operational level that supports strategic level performance indicators.

1.3.2.3. Are the existing performance indicators on an operational level within the university sufficient to support strategic level performance indicators according to literature?

A literature review will be conducted to evaluate the operational level performance indicators identified in the previous research question against performance indicators in literature. Identifying and filling the gaps in the list of performance indicators will provide management with a comprehensive view of the university's goals on different levels within in the university.

1.4. Research design and Methodology

A quantitative research design with modelling was selected for this study. This study seeks to develop and model a performance measurement framework for Stellenbosch University to measure and visualise progress on each of the strategic measurement indicators, institutional objectives, core strategic themes and the university as a whole.

The study starts with a brief overview of performance and performance measurement in organisations to recognise the complex nature of performance measurement which forms the basis of performance measurement frameworks in organisations.

A literature review on existing popular performance measurement frameworks will follow the review on performance and performance measurement. The goal is to find and/or develop a performance measurement framework that will track progress made with the goals set under the Strategic Framework 2019-2024 for Stellenbosch University.

An interactive model will be developed to visualise the performance for SU under the new Strategic Framework. Historical data and targets from the new Strategic Framework 2019-2024 for Stellenbosch University will be collected and incorporated into the model for visualisation.

Modelling is a tool widely used for analysis in quantitative research. (Briggs, 2005:589) Briggs (2005:589) states that "Statistical data lend themselves to graphical representation of values, interrelationships and operational systems." Modelling is a means to help understand the intricacy of the organisational environment as well as the complexity of the organisation's management systems. Modelling will enable management to develop a more holistic view of the inner workings of their institutions. (Fowler as cited in Briggs, 2005:591)

A literature review will follow on the cascading of performance indicators from a strategic level to an operational level. The goal is to identify performance indicators already in use in the university on an operational level which will support strategic level indicators and provide management with a holistic view of performance in the university. A literature review on performance indicators for one of the core strategic themes under the strategic framework will be done to identify gaps in the list of existing performance indicators in the university.

An interactive model will be developed to represent the performance indicators identified to support strategic level performance indicators. The model will be populated with simulated artificial data for the purpose of this thesis. Effectiveness will be calculated for some of the operational level performance indicators where targets can be allocated.

Interactive models visualising performance on a strategic level and operational level will assist management to track overall performance in the university as well as the ability to drill-down to lower levels in the university on faculty and department level.

1.5. Significance and motivation

1.5.1. Value of the research

Sorooshian *et al*., (2016:130) acknowledge the lack of a comprehensive model to measure performance in organisations. To the knowledge of the researcher, at the time of conducting

the research, no evidence was found of a performance measurement framework that measured composite effectiveness within a university on different levels in the same way we calculate effectiveness. The measurement model proposed can be generalised to any size tree, provided effectiveness can be calculated at each leaf of the tree. That should generally be possible where a value is compared to a target. The value of this research lies in a novel contribution to performance measurement systems for higher education institutions, as well as the application of the proposed methodology to other performance measurement frameworks in general.

1.5.2. Value for practice

Universities are expected to be competitive and survive in an ever changing environment, therefore the need to measure performance on different levels in the university. The performance measurement framework developed for Stellenbosch University calculates effectiveness for each of the indicators and measures, composite effectiveness for the institutional objectives, composite effectiveness for the core strategic themes and composite effectiveness for the university as a whole under the new Strategic Framework. The Effectiveness Score Card model for Stellenbosch University was demonstrated and accepted by University management as a novel management tool at Stellenbosch University.

The cascading of performance indicators from a strategic level to an operational level is supported and recommended in literature. Operational level performance indicators were put together and visualised in a model from the type of data usually collected in the University originally used for deans' reports[1]. The performance indicators were expanded with performance indicators suggested by literature to avoid gaps. The process of linking operational level performance indicators to strategic level indicators is depicted in Chapter 4. Performance calculations on an operational level is also possible and visualised in the model that should assist management to dill down to faculty and department level to identify areas of excellence and concern and to take corrective actions where needed.

1.6. Summary and conclusion

The purpose of this chapter is to give the reader an overview of the research conducted. Section 1.1 provided a background for this study, and section 1.2 provided the purpose for this study. The primary and secondary research questions based on the purpose and background of the

[1] Simulated artificial data sets were used for all the experiments reported in this thesis.

study followed in section 1.3. The research design and methodology chosen for the study are set out in section 1.4 followed by the contribution of these results to research and practice in section 1.5. The next chapter is a review of the most significant literature.

Chapter 2

Literature Review

2.1. Introduction

Performance only makes sense when the data from performance measures are used in decision-making, and decisions contribute to the creation or the management of performance. (Lebas & Euske, 2007:136-137)

Drucker (1986:99) claims that the performance management of service institutions will be seen as the central managerial challenge of a developed society. Osborne and Gaebler (as cited in Ogata & Goodkey, 2004:263) states that governments should engage in results-based performance, focusing on strategies that are successful in producing the desired results and stop rewarding failures. Results must be measured to tell success from failure in non-profit organisations.

Layzell (as cited in Alexander, 2000:419) states that the development of performance and outcomes measurement is to assess and monitor the effectiveness of universities and based on accountability. Performance-based planning and funding has become a means for governments to compare the productivity of one institution against another institution's performance.

Drucker (1986:120) states that institutions need efficiency (control of costs), but need effectiveness above all with the emphasis on achieving the right results. The biggest and the most important task for institutions is the need to learn how to manage performance.

Performance measurement, as stated by Osborne and Gaebler (as cited in Ogata & Goodkey, 2004), Layzell (as cited in Alexander, 2004) and Drucker (1986) is thus of great importance to universities and will become even more important in the near future.

A performance measurement framework that will measure performance and effectiveness at Stellenbosch University will assist management in decision-making and steering the university to where the university wants to be in the future.

The focus of sections 2.2.1 and 2.2.2 is to review the literature on performance, performance measurement and performance measurement frameworks to identify and/or develop a

performance measurement framework for Stellenbosch University. A literature review on key performance indicators and the cascading of strategic level performance indicators to operational level performance indicators will follow in section 2.2.3. It will be established if it is possible to create a model with operational level performance indicators for Stellenbosch University that will support strategic level performance indicators. Section 2.3 will summarise the literature review chapter.

2.2. Broad context theory base

Understanding performance, performance measurement and performance management is the first step before a performance measurement framework can be selected and/or developed for Stellenbosch University. The section commences with section 2.2.1 with a brief overview of performance, performance measurement and performance management.

2.2.1. Performance and performance measurement

Understanding performance will assist in incorporating performance characteristics in the performance measurement framework selected and/or developed for Stellenbosch University. Lebas (as cited in Lebas & Euske, 2014:128) explains performance as a complex set of time-based and causality-based indicators that will generate future results. Performance only means something when it is used in decision-making and the result of performance should be extensively discussed between key stakeholders or decision makers in the organisation.

The performance measurement framework to be selected and/or developed for Stellenbosch University should measure the performance of indicators individually and overall which should in turn encourage discussions among management and assist in decision-making for better future results for the university.

Lebas (as cited in Lebas & Euske, 2014:128) use the performance tree to illustrate how an organisation go through the process of creating performance. The performance tree analogy captures the complexity and the characteristics of growth and change in an organisation. The quality of the processes rest in part on the nutrients in the soil. The processes are the richness of the sap and the effective movement through the trunk and to the branches as visualised in Figure 2.1.

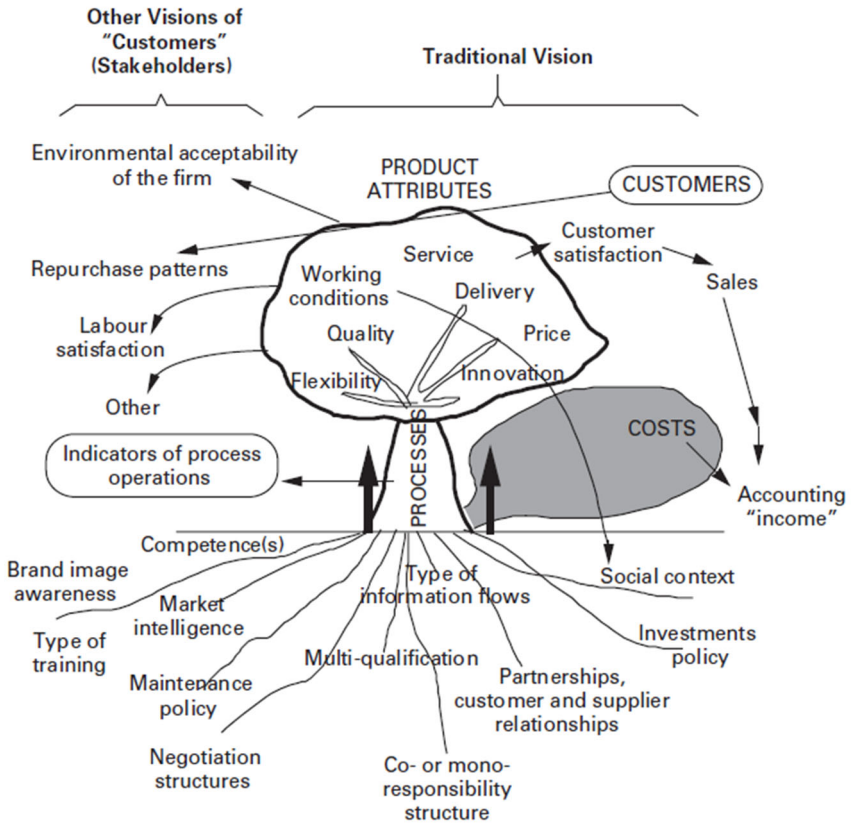

Figure 2.1: The performance tree (Source: Lebas & Euske, 2014:128)

Performance is a complex concept and multifaceted because it includes elements describing both the results and the processes creating the results. Performance is linked to value creation and value is created over time. A time frame therefore must be specified in addition to decision parameters and context. Performance measures and the underlying performance must be qualified as good or bad because performance is a relative concept that requires interpretation and judgement. (Lebas and Euske, 2007:134-136)

Characteristics to be incorporated in the performance measurement framework for SU, with reference to the performance tree, include: performance indicators concerned with inputs, activities and outputs measured according to a time frame. Visualisation should be incorporated into the model that will assist in judgement of the performance of the performance indicators.

Decision-making is connected to both strategic alignment and steering the organisation in the implementation of the strategic intent according to Lebas and Euske (2007:136-137).

The following procedures are required to manage and align performance in an organisation according to the organisation's strategic objectives:

- The value creation process, its context and time must be described.

- The performance model must be shared with relevant stakeholders.
- Decision rights must be divided and allocated on the basis of the model. Causal models are generally broken down into sub-models and each sub-model defines a domain of responsibility, e.g. the manager, a responsibility centre and/or teams.
- Performance is defined differently by different users. It is thus important to have a clear definition of performance and the steps to create results in the model.
- The indicators must be documented in an appropriated information system so that the results can be communicated for someone to do something.
- A reference for benchmarking must be chosen because performance is a relative concept and requires interpretation and judgement.
- Signals and messages coming from indicators must be evaluated. Performance include both qualitative and quantitative measures and should not be confused with what they only partially describe.
- All actions that are likely to improve the possibility that the result will be coherent with the strategic intent must be identified, evaluated and implemented. Performance is a relative concept and there must always be a comparison to quantify the performance. It is sometimes difficult to define if a reduction in e.g. late deliveries or expenses per total donations is an improvement or not. Such data must be compared with competitors or other users of similar processes to define if the performance is a relative improvement or not.

The proposed performance measurement framework model for SU should include the following processes distilled from Lebas and Euske's (2007:136-137) procedures: describing the performance measurement process in detail with key stakeholders; provide users with clear definitions of how performance is calculated and visualised in the model; add definitions, values, targets (benchmarking) and timelines for all performance indicators in the model; and add visualisation techniques (signals) in the model that will assist in interpreting the progress of the performance indicators.

Performance management encapsulate performance and performance measurement, but also indicates where performance measurement fits in the organisation as explained by the performance measurement cycle of Eckerson (2007). Eckerson (2009:4) explain performance management as a four-step virtuous cycle that involves the creation of strategy and plans, monitoring the execution of those plans, adjusting activity and objectives to achieve strategic goals as visualised in Figure 2.2.

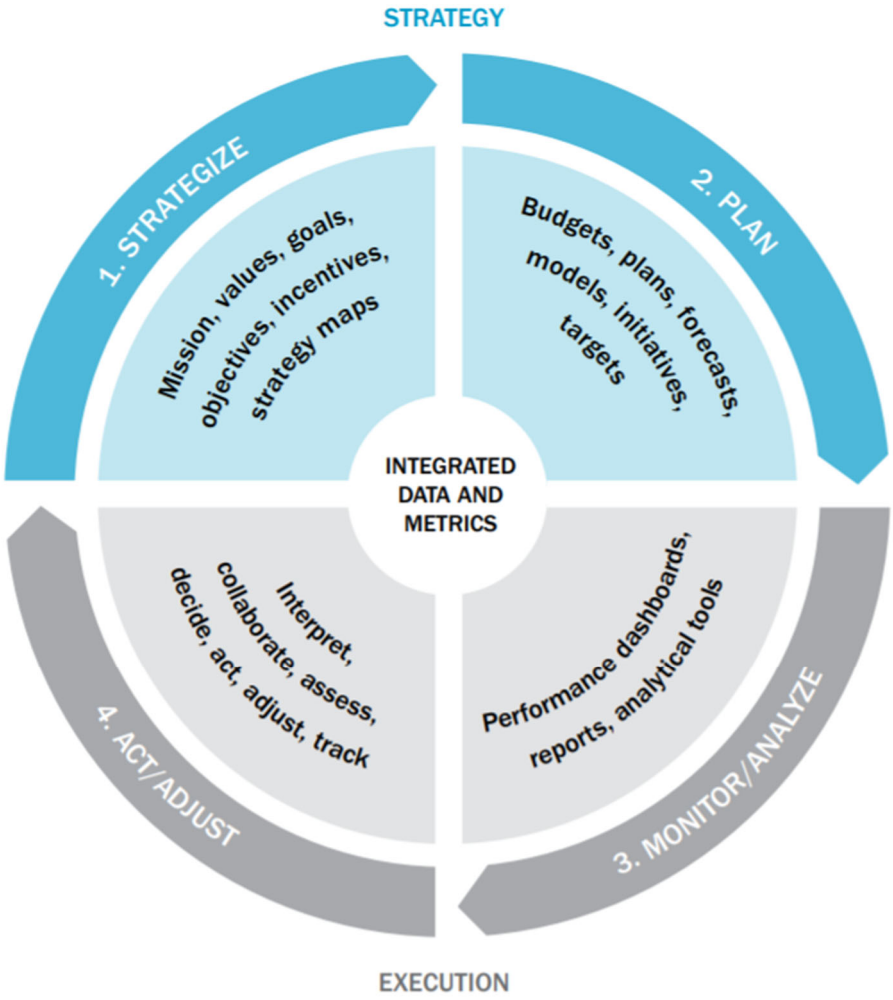

Figure 2.2: The performance management cycle (Source: Eckerson, 2009:4)

The starting point of performance management is strategy. Drucker (1986:102) states that "the starting point of effective work is a definition of the purpose and mission of the institution" and achievement is only possible when targets are specific, limited and clearly defined.

The new Strategic Framework developed for Stellenbosch University falls under '(1) Strategize' on Eckerson's (2009:4) performance management cycle, where the university developed a new vision and mission for the university (see Appendix A*: Vision 2040*), and core strategic themes, institutional objectives and indicators and measures (see Appendix B: Stellenbosch University's Core Strategic Themes 2019-2024 *[Source: Stellenbosch University]*). Values and targets were set for the indicators and measures under the strategic framework which falls under '(2) Plan' on the performance management cycle. The performance measurement framework and model proposed in this study fall under '(3) Monitor/Analyze' on Eckerson's (2009:4) performance management cycle, which will assist management to interpret, assess, decide, act, adjust and track performance under '(4)

Act/Adjust' on the performance management cycle. It is thus clear that a performance measurement framework will be a great advantage for the university and a will form an integral part of the university's performance management.

The need for a performance measurement framework has now been established and the next step is to develop a performance measurement framework for Stellenbosch University.

Section 2.2.2 is a review and discussion of performance measurement frameworks listed in literature. Section 2.2.2.1 will start with a review on popular performance measurement frameworks and then continue with section 2.2.2.2 listing performance measurement frameworks originated from combining elements from different performance measurement frameworks. Section 2.2.2.3 is a discussion on the possible use of one or more of the performance measurement frameworks for Stellenbosch University and concludes with identifying characteristics to be included in a performance measurement framework under section 2.2.2.4.

2.2.2. Performance measurement frameworks

Performance measurement frameworks have been used in business organisations for many years and recently also in higher education institutions.

2.2.2.1. Popular performance measurement frameworks in literature

The following performance measurement frameworks have been developed and recorded in literature to assist organisations in measuring performance:

- *DuPont developed a pyramid of financial ratios* as illustrated in Figure 2.3 which linked accounting measures and financial ratios, e.g. Return On Net Assets (RONA), Return On Investment (ROI) and Return On Equity (ROE) to more operational indicators and measures. An advantage of DuPont's model is that it links financial measures with operational indicators. A disadvantage is that the model is mainly focused on financial measures. (Chantler as cited in Neely *et al*., 2007:144)

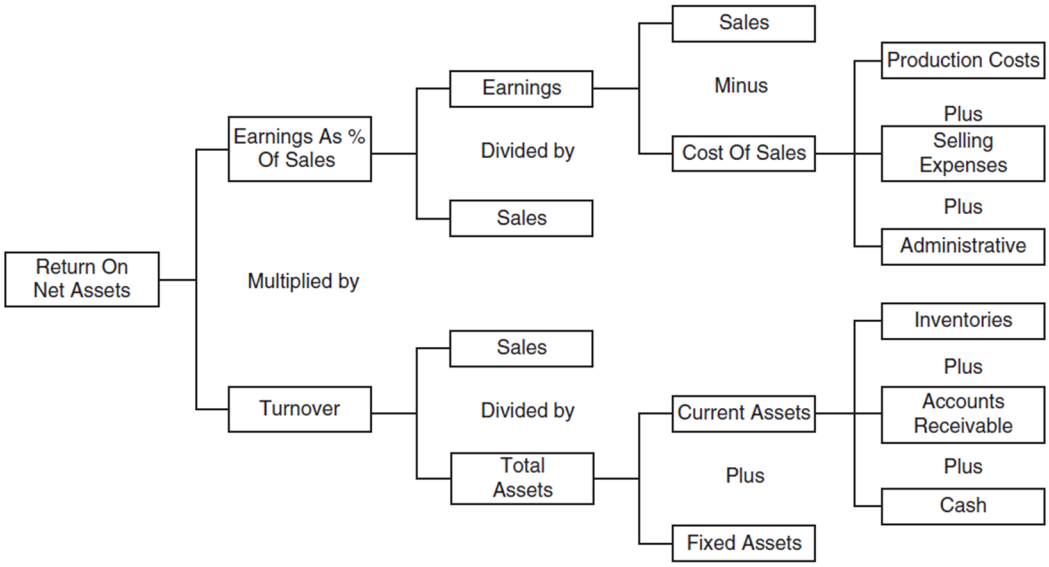

Figure 2.3: The DuPont model (Source: Bititci, 2015: 254)

- *The Performance Measurement Matrix (PPM)* (see Figure 2.4) was developed by Keegan, Eiler and Jones in 1989 (as cited in Neely *et al*., 2007:145). The PPM integrates financial and non-financial, and internal and external aspects of business performance. The inherent flexibility of the design means that any measure of performance can be accommodated in the framework.

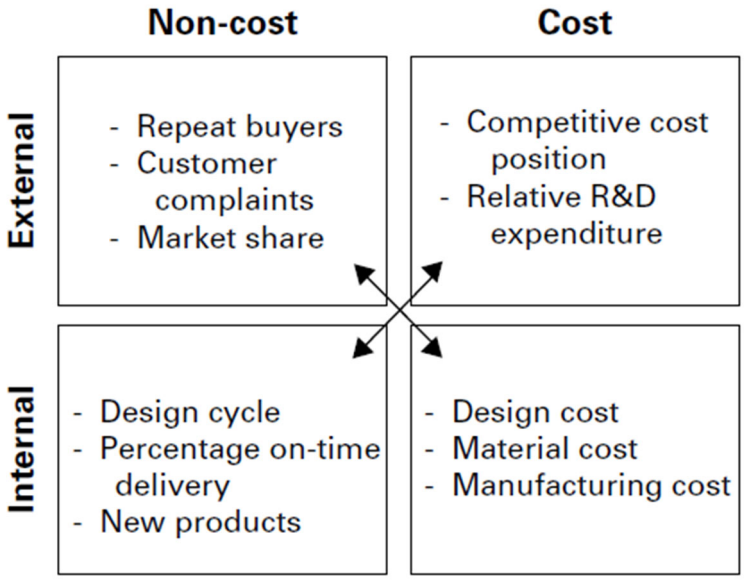

Figure 2.4: The performance measurement matrix (Source: Neely et al., 2007:145)

- *The SMART (strategic measurement and reporting technique) pyramid* visualised in Figure 2.5, also known as *the Performance Pyramid* was developed by Lynch and Cross in 1991 to eliminate the traditionally financial focused measurement system. (Lynch & Cross as cited in Neely *et al*, 2007:145). The pyramid supports internally and externally

focused measures of performance and it adds the notion of cascading measures down the organisation. Measures at department level reflect the corporate vision as well as internal and external business objectives.

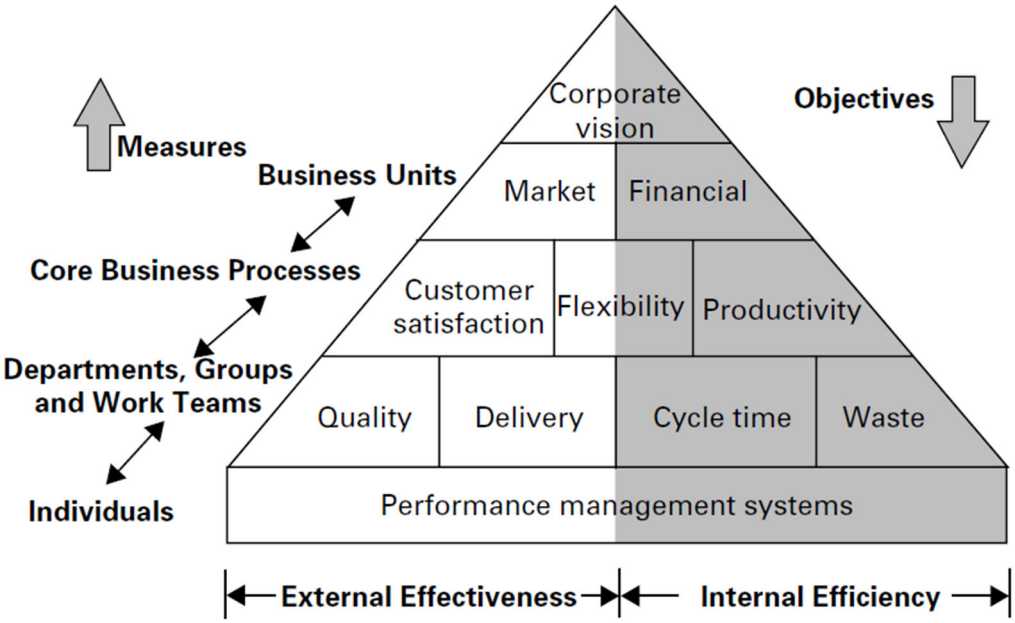

Figure 2.5: The SMART Pyramid (Source: Neely et al., 2007:146)

- The *Results-Determinants framework* was developed by Fitzgerald *et al.* in 1991 (as cited in Neely *et al*., 2007:146) and illustrated in Figure 2.6 as a framework to classify measures into results and those that focus on the determinants of those results. The results category covers financial and competitiveness related performance measures, also seen as lagging indicators and the determinants category includes performance measures for quality, flexibility, resource utilisation and innovation, also seen as leading indicators.

Results	Competitiveness
	Financial performance
Determinants	Quality
	Flexibility
	Resource utilization
	Innovation

Figure 2.6: The Results-determinants framework (Source: Neely et al., 2007:147)

- *The input-process-output-outcome framework* illustrated in Figure 2.7 was developed by Brown in 1996 (as cited in Neely *et al*., 2007:146-147) to further develop linking measures through cause and effect relationships. The model assumes a linear relationship between the five stages in a business process and the measures of their performance. The five stages are defined as inputs, processing system, outputs, outcomes and goals. The distinction between the different categories of measures are useful, especially the outputs and outcome measures in the public sector.

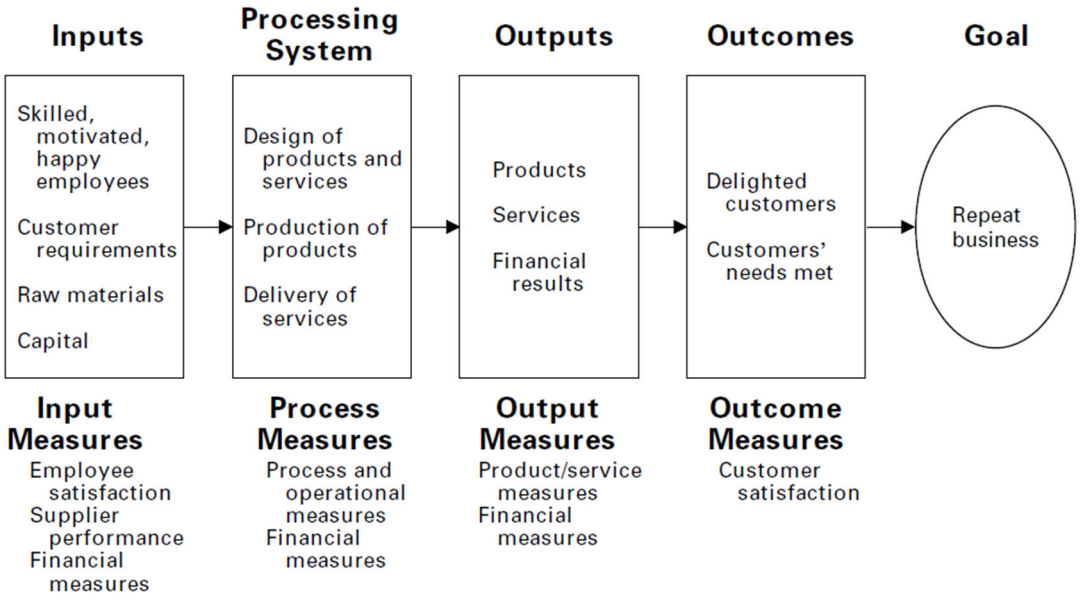

Figure 2.7: The input-process-output-outcome framework (Source: Neely et al., 2007:147)

- *The balanced scorecard (BSC)* proposed by Kaplan and Norton (as cited in Neely, *et al*., 2007:146-148) and visualised in Figure 2.8, identifies four different perspectives of performance: financial, customer, internal business and innovation and learning. Financial performance, customer and internal operational performance as well as ongoing improvement and future performance should all be given equal weightings according to the Kaplan and Norton. An advantage of the BSC is that the BSC links measurement to the organisations strategy more explicitly. Shortcomings identified in the BSC are the absence of a competitiveness dimension, the absence of perspectives on human resources and employer satisfaction, supplier performance, product or service quality and environmental or community considerations.

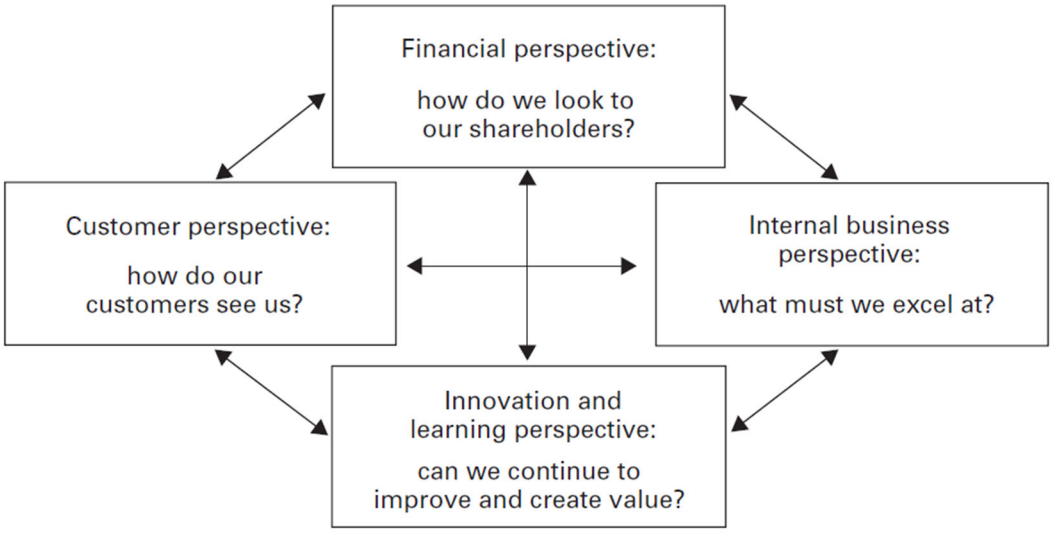

Figure 2.8: The balanced scorecard (Source: Neely et al., 2007:148)

2.2.2.2. Performance measurement frameworks developed by combining elements out of two or more existing performance measurement frameworks

Parmenter (2015:299) states that organisations should follow the methodology that is best for the organisation and at times it will be necessary to cut an exercise from one methodology and use it with an exercise of another methodology. Nayeri *et al*. (2008:29) found that various models used for measurement in literature complement each other, e.g. the BSC, SWOT analysis, value chain, portfolio analysis and DEA techniques.

The following performance measurement frameworks were developed by combining elements from existing performance measurement frameworks:

- *The European Foundation for Quality Management's Business Excellence Model (EFQM model)*, visualised in Figure 2.9, and its US equivalent, the Malcom Baldridge National Quality Award address many of the shortcoming in the BSC, although the framework is not a measurement framework but rather a self-assessment framework. The framework highlights enablers of performance improvement and indicates result areas that should be measured according to Neely and Adams (as cited in Neely *et al*, 2007:149).

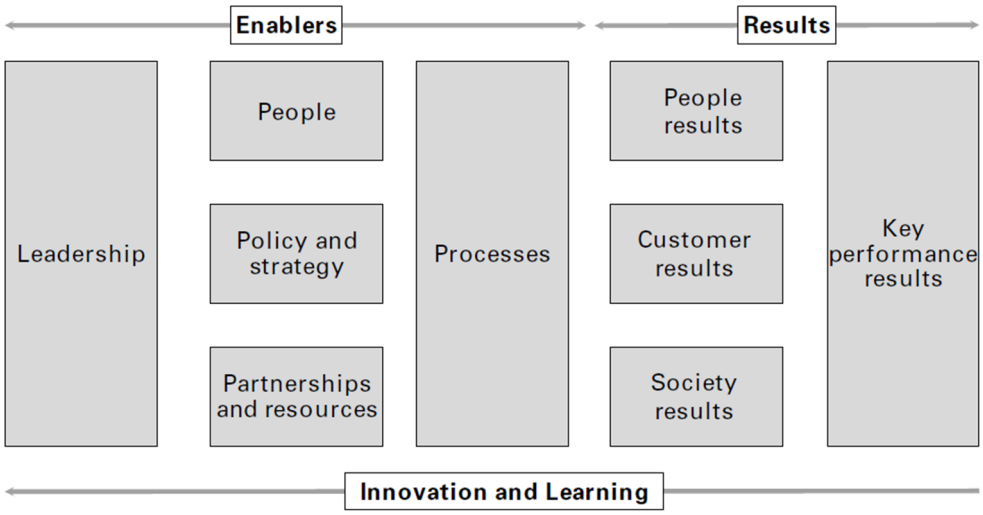

Figure 2.9: The European Foundation for Quality Management framework (Source: Neely et al., 2007:149)

The EFQM model has adapted the BSC concept to education according to Karathanos and Karathanos (2005:222, 229).

- *The Performance Prism* developed by Neely *et al*. (2007:151-156) and visualised in Figure 2.10 links stakeholder contribution with stakeholder satisfaction through processes, strategies and capabilities. The performance prism defines the following set of performance measures: Stakeholder satisfaction (who are the stakeholders and what do they want), strategies (strategies that needs to be put in place to satisfy stakeholder satisfaction), processes, capabilities (capabilities that are needed to operate and enhance the processes), and stakeholder contribution (what contributions are needed to maintain and develop the capabilities).

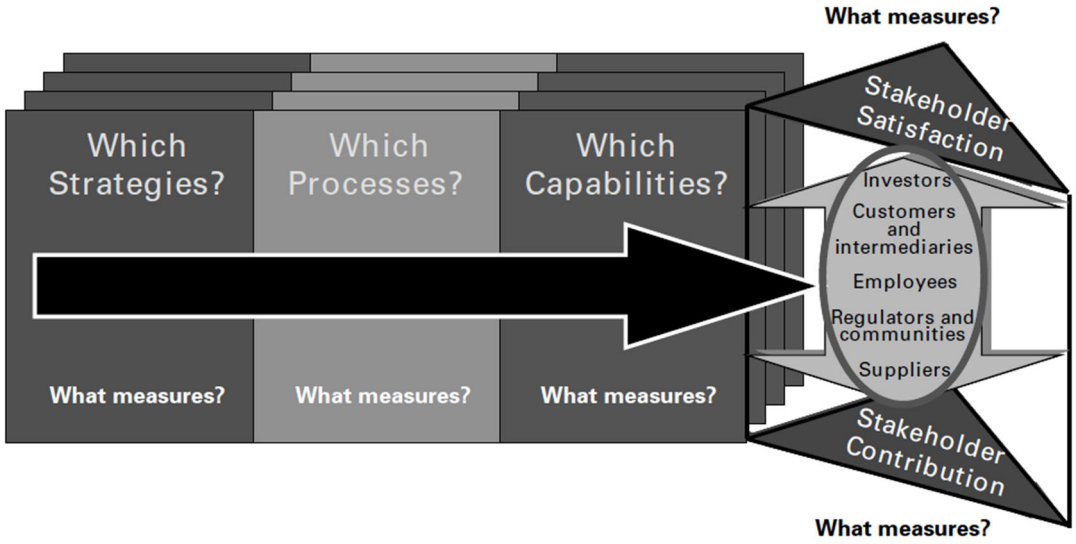

Figure 2.10: The performance prism (Source: Neely et al., 2007:155)

The Performance Prism developed by Neely *et al*. in 2001 (2007:151-156) is based on the key characteristics of the BSC, EFQM model, PPM, SMART Pyramid and the results and determinants framework.

- Stacy Barr (2019) developed *the Performance Measurement Process (PuMP)* methodology to help organisations find measures that drive performance. Performance measurement is a process, a series of necessary steps to select, implement and use measures that will help improve performance. Figure 2.11 lists the eight steps in the PuMP methodology.

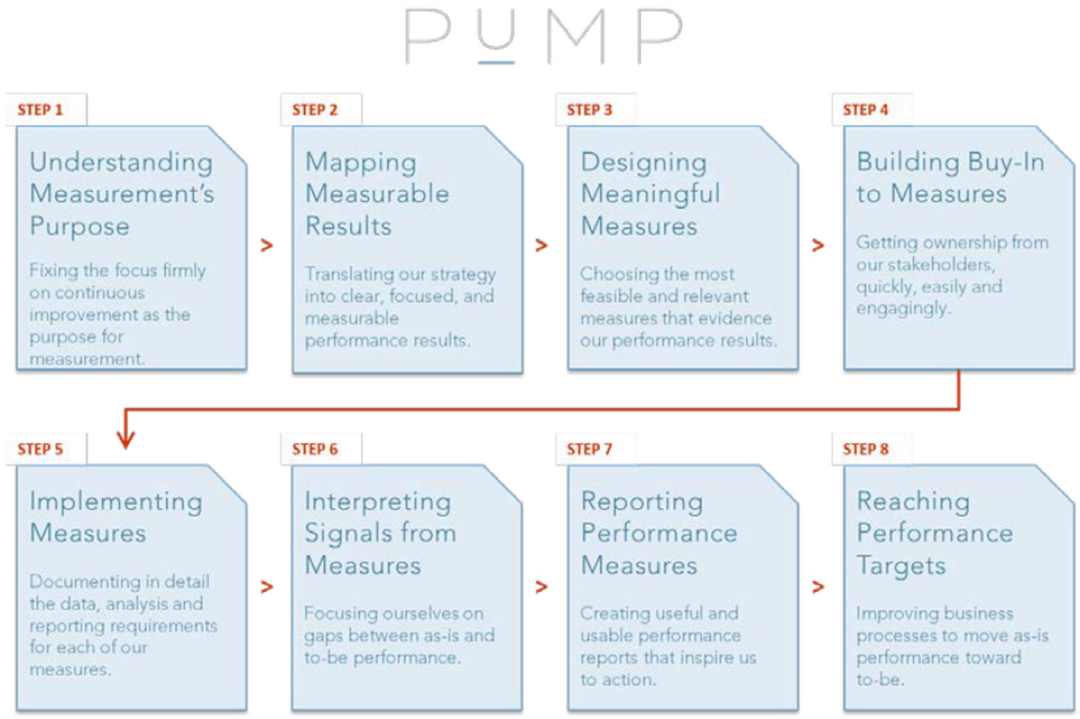

Figure 2.11: Performance Measurement Process (Source: Barr, 2019:13)

- Parmenter (2015:300) developed a *Winning-KPIs methodology* that is based on the work of Kaplan and Norton (the developers of the BSC) to measure performance in organisations. The winning-KPIs methodology states that: the primary role of performance measures is to help staff focus on the critical success factors of the organisation day-in and day-out; the organisation's critical success factors are the core to finding KPIs; the winning-KPI methodology differentiates between Key Performance Indicators (KPIs), Performance Indicators (PI), Key Result Indicators (KRIs) and Result Indicators (RIs) (see Figure 2.12); and an organisation needs to look at six perspectives: environment and community; staff satisfaction; innovation

and learning; financial results; customer focus; and internal processes, and not only to the four perspective referred to in the BSC.

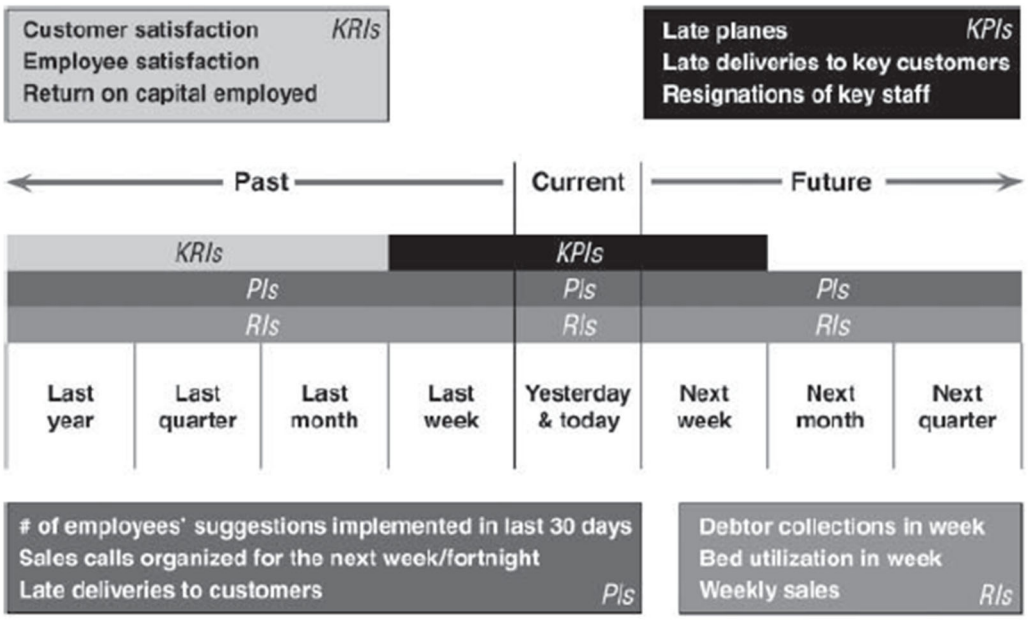

Figure 2.12 The difference between KRIs, RIs, KPIs, PIs and the time zones (Source: Paramenter, 2015:19)

- Wang (2010:75) proposed a *performance measurement framework based on the Performance Pyramid concept and the Balanced Scorecard approach* for the University of Twente as illustrated in Figure 2.13. The framework starts with the university's vision with two main performance dimensions, academic and management at the top of the pyramid. Academic performance is the core and management performance is the enabler to the performance in a university. The two main dimensions are divided into four sub-dimensions; research, education, finance, and human resources, representing the four dimensions in a balanced scorecard concept. Indicators in the four dimensions in the middle and bottom of the pyramid construct an operational view of performance measurement for managers in universities. Information from each sub-dimension will be summarised and reviewed by high-level managers in the university to form a main measurement on academic and management performance in the university. Managers at lower levels need operational indicators with more specific information. (Wang, 2010:12)

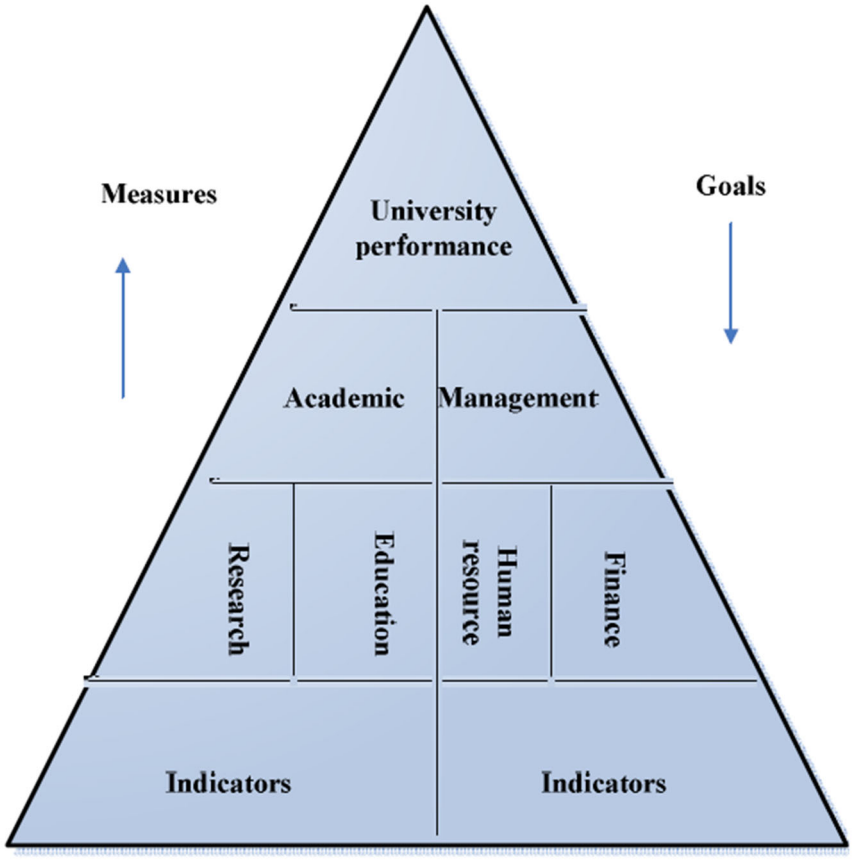

Figure 2.13: Performance management framework for universities (Wang, 2010:21)

- Asif and Searcy (2014:984) provides a structured framework for determining key performance indicators and the development of a *composite index* for measuring performance in higher education institutions (HEIs). The framework used by Asif and Searcy (2014) is based on the application of the Analytical Hierarchy Process (AHP). Asif and Searcy (2014:986) suggest that performance indicators can be categorized more effectively by the key concerns of HEIs namely research, teaching, service and financial performance. The hierarchy created by Asif and Searcy (2014:992) in the framework consist of the objective (level 1), criteria (level 2), indicators (level 3) and the importance of the indicators against a 5 point rating scale as visualised in Figure 2.14.

  The goal (level 1) for their case study is "Integrated Performance assessment in HE." The criteria (level 2) consist of: research, teaching, service and financial performance. Level 3 consist of the KPIs identified for the case study. Level 4 list the importance of the indicators against a five-point rating scale. The five-point

rating scale consists of O – Outstanding; G – Good; A – Average; F – Fair and P – Poor.

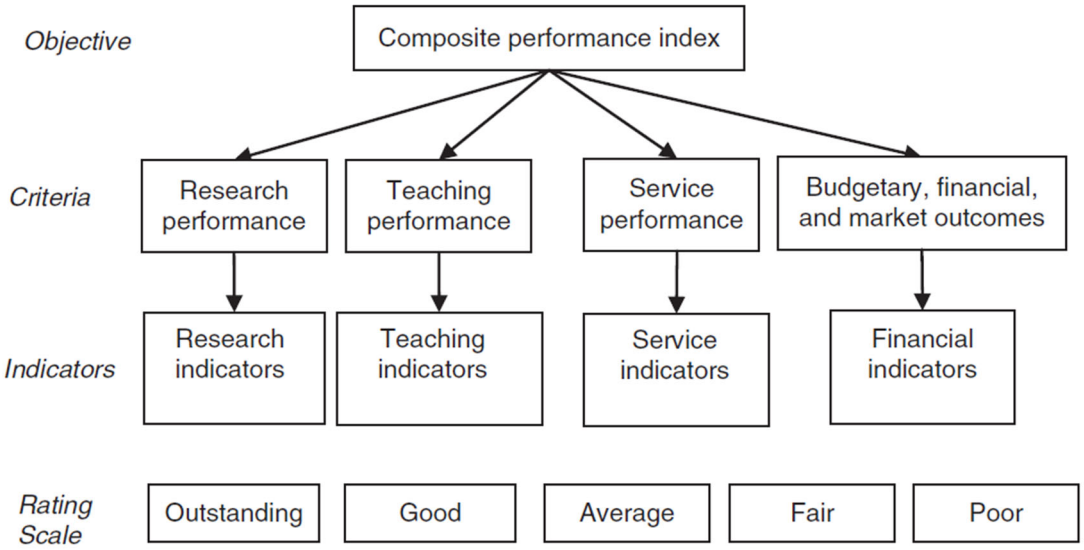

Figure 2.14: Different levels in the hierarchy for integrated performance measurement and the scale for pairwise comparison of criteria (Source: Asif & Searcy, 2014:994)

Seven faculty members who were actively involved in the performance process of the college where the study was undertaken by Asif and Searcy (2014) provided data for the pairwise comparison to rate the four sets of criteria to get to priority weights shown in Figure 2.15. The four criteria are: research, teaching, service, and financial as seen in Figure 2.14. The calculations were made using a software named 'Expert Choice.'

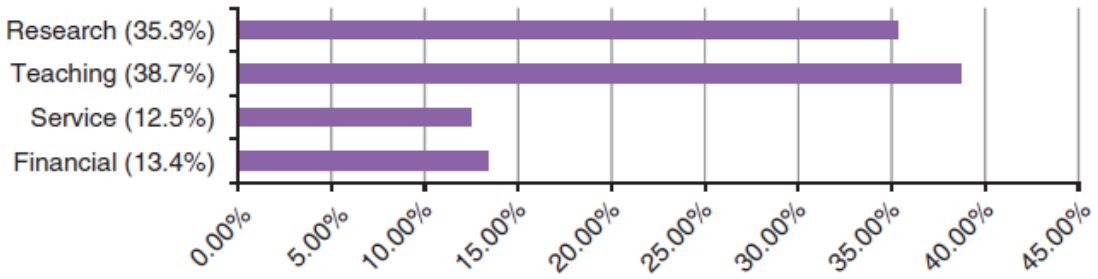

Figure 2.15 Priority weights allocated to the four dimensions of performance assessment in a study done by Asif and Searcy (2014:994)

The administrator of the HE in the case study was then asked to rate the performance of the individual PIs identified in the study relative to its peers by giving all the key PIs a rating of O, G, A, F or P. Pairwise comparison was done and the eigenvector

was calculated and the resulting priority weights of O, G, A, F and P are found as 0.513, 0.129, 0.063, and 0.003 as seen in Table 2.1. (Asif & Searcy, 2014:995)

Table 2.1 Pair-wise comparison judgement matrix (Asif & Searcy, 2014:995)

	Outstanding	Good	Average	Fair	Poor	Priority weights
Outstanding	1	3	5	7	9	0.513
Good	1/3	1	3	5	7	0.216
Average	1/5	1/3	1	3	5	0.129
Fair	1/7	1/5	1/3	1	3	0.063
Poor	1/9	1/7	1/5	1/3	1	0.033

The composite index was then calculated as follows (see Table 2.2):

Composite priority weight (D) = Priority weights of the PIs (I) x Performance of the PIs compared against the college's peer's performance on the PIs (B) with the values from Table 2.1. The maximum possible score is then calculated by multiplying (I) with 0.513 from Table 2.1. The composite index for each dimension (or criterion) is the ratio of the sum of the composite priority weights (D) and the sum of the maximum possible scores (E) normalised to a ten-point rating system, i.e. (ΣD ÷ ΣE) x 10.

Table 2.2: Composite performance index calculations (Asif & Searcy, 2014:997)

Indicators related to the Research criteria: (C) Weight for Research = 0.353	(I) Weights of the indicators	(A) Overall Priority weights = C x I	(B) Performance against peers	(D) Composite priority weight = A x B	(E) Max. possible score = A x 0.513	Composite performance index = (sum D ÷ sum E) x 10
Number of research publications	0.250	0.088	A (0.129)	0.011	0.045	
Number of research projects	0.089	0.031	F (0.063)	0.002	0.016	
Percentage of faculty winning academic grants	0.181	0.064	P (0.033)	0.002	0.033	
Number of technology projects	0.073	0.026	P (0.033)	0.001	0.013	
Number of research projects addressing local needs	0.155	0.055	F (0.063)	0.003	0.028	
Percentage of faculty attending conferences	0.097	0.034	F (0.063)	0.002	0.017	
Research impact	0.155	0.055	P (0.033)	0.002	0.028	

Indicators related to the Research criteria: (C) Weight for Research = 0.353	(I) Weights of the indicators	(A) Overall Priority weights = C x I	(B) Performance against peers	(D) Composite priority weight = A x B	(E) Max. possible score = A x 0.513	Composite performance index = (sum D ÷ sum E) x 10
Research Performance	**1.000**	**0.353**		**0.023**	**0.180**	**1.28**

The composite index calculated for "research performance" in the study done by Asif and Searcy (2014:995) is 1.28 (rounded). This is calculated by the sum of the composite priority weights for "research" which is 0.023 (rounded) and the sum of maximum possible score for "research" which is 0.180 as seen in Table 2.2. The ratio of these two values normalized to a ten-point rating system gives 1.28 (rounded) for "research performance." The composite index for "teaching performance" is calculated to be 7.37 (rounded); the composite index for "service performance" is calculated to be 4.00; and the composite index for "financial performance" is calculated to be 3.33 (rounded) in the study. (Asif & Searcy, 2014:996-997) The authors plotted the composite performance on a spider chart for the college as shown in Figure 2.16.

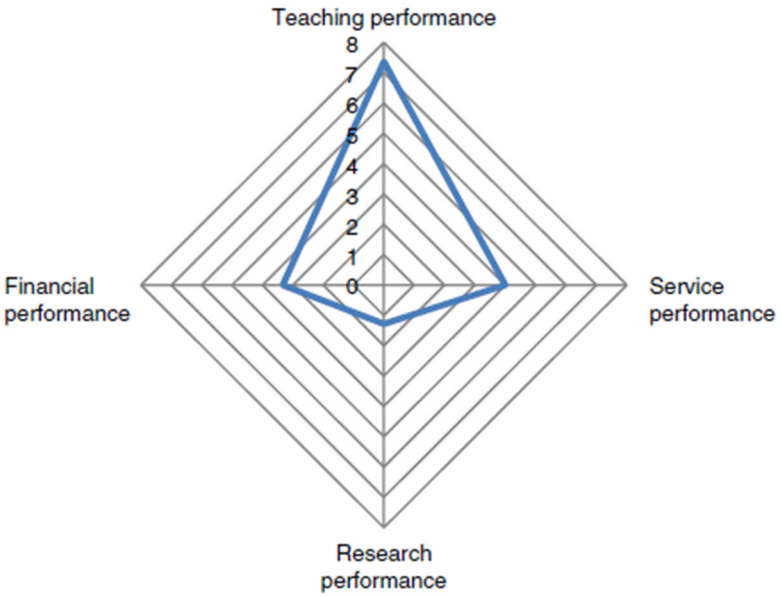

Figure 2.16 A spider chart showing the composite performance scores calculated for research, teaching, service and financial by Asif and Searcy (2014:998) in their study.

> The composite index approach applied by Asif and Searcy (2014:99) allows for the integration of large amounts of data and for comparison and benchmarking of performance indicators.

The listed performance measurement frameworks are examples of the complex nature of performance and performance measurement in organisations. The following section will evaluate the appropriateness to use one or more of the listed frameworks to measure performance at Stellenbosch University.

2.2.2.3. Discussion of the listed performance measurement frameworks

Performance measurement frameworks are developed to assist an organisation to improve performance. This section evaluates the listed performance measurement frameworks in sections 2.2.2.1 and 2.2.2.2 for a possible performance measurement framework to be used to measure performance at Stellenbosch University.

DuPont's pyramid of financial ratios focus mainly on financial measures and are therefore not suitable to be used in a service institution like a university. *The Performance Measurement Matrix (MMP)* is simplistic in nature but lack structure and detail (Bititci, 2015:255) and are therefore not appropriate to use for this study. *The SMART pyramid*, introduced by Cross and Lynch in 1991, (as cited in Neely *et al*., 2007:145) adds the notion of cascading measures down the organisation towards the organisation's objectives, which is applicable to Stellenbosch University's strategic framework, but Wang (2010:12) criticised the framework on the basis that the framework does not make use of indicators within the framework. *The SMART pyramid* also has a strong focus on business-like activities for example cash flow, profitability and market share and are therefore not suitable to measure performance in higher education.

The Results-Determinants Framework (RDF) includes both lagging (financial and competitive) and leading (quality, flexibility, resource utilisation and innovation) indicators but fail to combine other non-financial performance measurement indicators, for example, indicators related to stakeholders. (Neetu, Sushil, & Mahim as cited in Sorooshian *et al*., 2016:126) The RDF is thus also not suitable as a performance measurement framework for Stellenbosch University because stakeholders are an important aspect of a university and should therefore be included in the performance measurement framework. *The input-process-output-outcome framework* is useful in organisations, especially the distinctions between the categories that identify the indicators that should be measured, but the model assumes a linear relationship

between the five stages in the business process to measure performance which in not always true in higher education and therefore not suitable to use.

The Balanced Scorecard is criticised for being difficult to create and is time-consuming to implement and are therefore not widely used in higher education. Managers of universities according to Hladchenko (2015:175) lack skills and experience in developing the tool. The BSC is based on four dimensions and the SU's strategic framework consist of six core strategic themes. Human resources, i.e. under the strategic theme "Employer of choice," is one of the core strategic themes in the new strategic framework for SU. These dimensions do not map directly to SU's Strategic Framework 2019-2024, which indicates that the BSC framework is also not suitable for Stellenbosch University.

Hawari and Tahar (2015) developed an interactive system dynamics simulation model to analyse performance in a university in Malaysia. The model integrates both the BSC model and the systems dynamics (SD) modelling method. Hawari and Tahar (2015:362) identified shortcomings in the BSC method that can be addressed by combining the BSC with SD modelling. Shortcomings in the BSC model mentioned by the authors include: the BSC model does not express dynamic relationships and feedbacks and does not help policymakers understand if performance measures ought to be an outcome (or lag) indicator or a driver (or lead) indicator. SD modelling can address shortcomings identified in the BSC model because SD modelling can help explore the links between 'levers' and 'outcomes'; the modelling technique address dynamic, long-term policy problems; it focuses on 'stocks' and 'flows' within processes and the relationships between them. Advantages of combining BSC and SD modelling include: a dynamic holistic feedback view on performance system; identify key performance indicators and their relationships; as well as addressing the impacts of different policies on the system. (Hawari & Tahar, 2015:362) Although the performance measurement framework proposed by Hawari and Tahar is an improvement on the BSC, the framework is still not suitable for Stellenbosch University because the Strategic Framework consists of six dimensions and the new framework proposed by Hawari and Tahar kept the four dimensions of the BSC.

The EFQM model is criticised in literature for being vague with a focus on self-assessment as a benchmark of the organisation's position among competitors. (Sorooshian *et al*., 2016:125) The performance measurement framework for SU should measure performance within the university and are therefore not suitable to track performance under SU's new Strategic Framework.

The Performance Prism is concerned with the wants and needs of stakeholders and criticised by Milad (as cited in Sorooshian *et al*., 2016:127) for not truly being proven as the best measurement framework to work in practice. The *Winning-KPIs* of Parmenter (2015) is based on the BSC framework but expanded to include six perspective and not only the four from the BSC. The winning-KPI methodology is more concerned with identifying KPIs for the organisation which in not applicable for this study because performance indicators are already specified under the SU's Strategic framework. The focus for this study is more concentrated on the measurement of performance for the university. *The Performance Measurement Process (PuMP)* is focused on assisting organisations to find measures that drive performance and not very specific in the process of how to measure performance under the framework.

The *composite index approach* applied by Asif and Search (2014) shows a similar hierarchical structure as the Strategic Framework at Stellenbosch University which makes this approach a possibility to consider. Asif and Searcy (2014) list level 1 as the goal – Integrated Performance Assessment in HE; level 2 - criteria (research, teaching, service, and financial performance); level 3 – indicators; and level 4 – performance ratings of the PIs. The Strategic Framework for Stellenbosch University allocates levels as follows: Level 0 for Institutional performance; level 1 – Core strategic themes (A thriving Stellenbosch University; A transformative student experience; Purposeful partnerships and inclusive networks; Networked and collaborative teaching and learning; Research for impact; and Employer of choice); level 2 – Institutional objectives; and level 3 indicators and measures.

The drawback of the framework develop by Asif and Searcy (2014) is the benchmarking of performance indicators against peer institutions. The administrator of the HE rate the performance of the PIs relative to its peers by giving all the key PIs a rating of O, G, A, F or P which is then translated into values and incorporated into the composite index calculation. Performance within the university is then not calculated which is the main goal for the performance measurement framework for Stellenbosch University and can therefore not be used.

A new performance measurement framework is therefore needed to measure performance at Stellenbosch University under the new Strategic Framework. The following section lists characteristics to be included in the new performance measurement framework identified from the listed performance measurement frameworks from the previous sections.

2.2.2.4. Characteristics to be included in the performance measurement framework to be developed for SU

The performance measurement framework for SU should incorporate key characteristics identified from popular performance measurement frameworks because they present good practice gained from experience.

Neely *et al*., (2007:149-150) combined a list of key characteristics of performance measurement frameworks after reviewing popular performance measurement frameworks:

- The framework should provide a balanced picture of the organisation, with financial and non-financial measures, internal and external measures as well as efficiency and effectiveness measures.
- The framework should give a clear overview of the organisation's performance.
- All areas of performance should be reflected in the framework.
- The framework should be comprehensive. All performance measures in an organisation should be mapped on a framework and areas that need greater focus or where there are omissions should be identified.
- Performance measures should be integrated across the organisation's functions as well as through its hierarchy.
- Results and their drivers should be measured so that the performance management system can provide data for monitoring past performance as well as to plan for future performance.
- Ballantine and Brignall (as cited in Neely *et al*., 2007:150) identified the need to include non-core measures that should be implemented which are consistent with management techniques and will improve initiatives that exist within the organisation, e.g. benchmarking and activity-based costing management.

A key characteristic to be included in the list, from the composite index approach, is to set priorities by allocating weights to performance indicators in the organisation.

More characteristics to be incorporated in the performance measurement framework with reference to the performance tree from Lebas and Euske, (2014:128), include: performance indicators concerned with inputs, activities and outputs measured according to a time frame; and the incorporation of visualisation techniques in the model which will assist in judgement of the performance of the indicators.

Procedures extracted from Lebas and Euske (2007:136-137) after the performance measurement framework has been developed should include: describing to key stakeholders in detail the performance process with clear definitions of how performance is calculated and visualised; add definitions, values, targets (benchmarking) and timelines for all performance indicators in the model; and add visualisation techniques (signals) in the model that will assist in interpreting the progress of the performance indicators.

Chapter 3 provides a detailed approach to the development of a performance measurement framework for Stellenbosch University.

The following section is a review on performance indicators to understand the role of performance indicators in the organisation and performance indicators on different levels in the organisation.

2.2.3. Key Performance Indicators

The Strategic Framework for Stellenbosch University consist of performance indicators on a strategic level and this section seeks to understand the characteristics of performance indicators from literature and the possibility to develop a model with operational level performance indicators to support strategic level performance indicators.

PWC (2013:2) defines key performance indicators (KPIs) as "factors by reference to which the development, performance or position of the business of the company can be measured effectively." Parmenter (2015:xvii) states that performance measures should have a profound impact on the organisation. Measurement has the following characteristics: a tendency to make things happen in an organisation; improves visibility and focuses attention on what matters; improves objectivity; improves understanding, decision-making and execution; improves performance; facilitates feedback; and helps the organisation to prepare for the future by encouraging timely feedback and looking forward.

KPIs should be derived and reflect the organisation's goals and should measure progress towards the achievement of these goals. KPIs should be based on criteria that make it suitable for further analysis and the criteria most often referenced for KPIs are those of SMART: Specific, Measurable, Achievable, Realistic and Timely, proposed by G. T Doran. SMART was extended to SMARTER, with the added criteria of Explainable and Relative, which are applied by many organisations because KPIs must also be easy to understand and relative so that the KPIs still apply when the organisation grows.

KPIs link the organisation's vision to individual action and the ideal situation is where KPIs cascade from level to level in the organisation as illustrated in Figure 2.17. (Performance Management and KPIs, 2020) Critical Success Factors (CSF), also known as Key Result Areas (KRAs) are a limited number of areas in which results will ensure successful competitive performance for the organisation. KPIs provide data that will enable organisations to decide whether CSFs have been met and if goals have been achieved (see Figure 2.15). (Critical Success Factors, 2020)

Figure 2.17: How KPIs fit into the organisation (Source: Performance Management and KPIs, 2020, www.mindtools.com/pages/article/newTMM_87.htm)

KPIs, according to Eckerson (2009:6), embodies a strategic objective and measure performance against a goal and consist of the following five elements:

1. KPIs measures performance against specific targets.
2. The targets of KPIs have ranges of performance, above, on or below the target.
3. The ranges of performance are encoded in software and performance is then visually displayed e.g. in green, yellow and red.
4. Time frames are assigned to targets by which they must be accomplished.
5. Targets are measured against a benchmark,

Eckerson (2009:11) and Parmenter (2015:9) differentiates between outcome and driver KPIs. Outcome KPIs, also known as lagging indicators measure the output of past activity and driver KPIs, also known as leading indicators measure activity that have a significant impact on

outcome KPIs. Driver KPIs measure activities in its current state and are more powerful than outcome KPIs. (Eckerson, 2009:11)

Performance Indicators (PIs) are found on different levels in the organisation. The University of Sydney refers to an institutional KPI framework at their university with core KPIs at two levels. Level one KPIs provide a more aggregated overview of the university and level two KPIs provides granular and complementary information to support level one KPIs. (The University of Sydney, 2014)

Eckerson (2009:13) refers to strategic, tactical and operational dashboards as listed in Table 2.3. Strategic dashboards consist of outcome KPIs, operational dashboards show driver KPIs and operational metrics and tactical dashboards have a mix of outcome and driver KPIs.

Table 2.3: Type of performance dashboards in a company. (Source: Eckerson, 2009, https://tdwi.org/research/2009/01/bpr-1q-performance-management-strategies.aspx)

	STRATEGIC	TACTICAL	OPERATIONAL
Focus	Execute strategy	Optimize process	Control operations
Use	Management	Analysis	Monitoring
Users	Executives	Managers	Staff
Scope	Enterprise	Departmental	Operational
Metrics	Outcome KPIs	Outcome and driver KPIs	Driver KPIs
Data	Summary	Detailed/summary	Detailed
Sources	Manual, external	Manual/core systems	Core systems
Refresh cycle	Monthly/quarterly	Daily/weekly	Intraday
"Looks like a..."	Scorecard	Portal	Dashboard

Operational dashboards are populated with detailed data and consist of driver KPIs and operational metrics, many of which drive higher-level KPIs. Organisations consist of multiple levels of management which may need their own dashboards and the multiplicity of interlocking dashboards is best understood through the concept of cascading, according to Eckerson (2009:13-14). KPIs cascade from higher levels to lower levels of the organisation and from strategic dashboards to tactical and operational dashboards in aligned organisations. Eckerson (2009:14) mentions that KPIs generally cascade between two and three organisation levels. Eckerson (2009:14-17) refers to vertical and horizontal cascading.

Vertical cascading as illustrated in Figure 2.18 provide executives a line-of-sight of performance across all groups and levels of the organisation. Vertical cascading enables executives to monitor their execution of strategy and pull the right levers to get the organisation back on track. The outcome drivers at executive level is repeated at each level in the organisation. Workers at all levels understand how their efforts contribute to help the organisation achieve its goals. Vertical cascading engenders friendly competition among peer groups within an organisation when organisations uses dashboards to publish performance results across peer groups using identical metrics (Eckerson, 2009:14, 17)

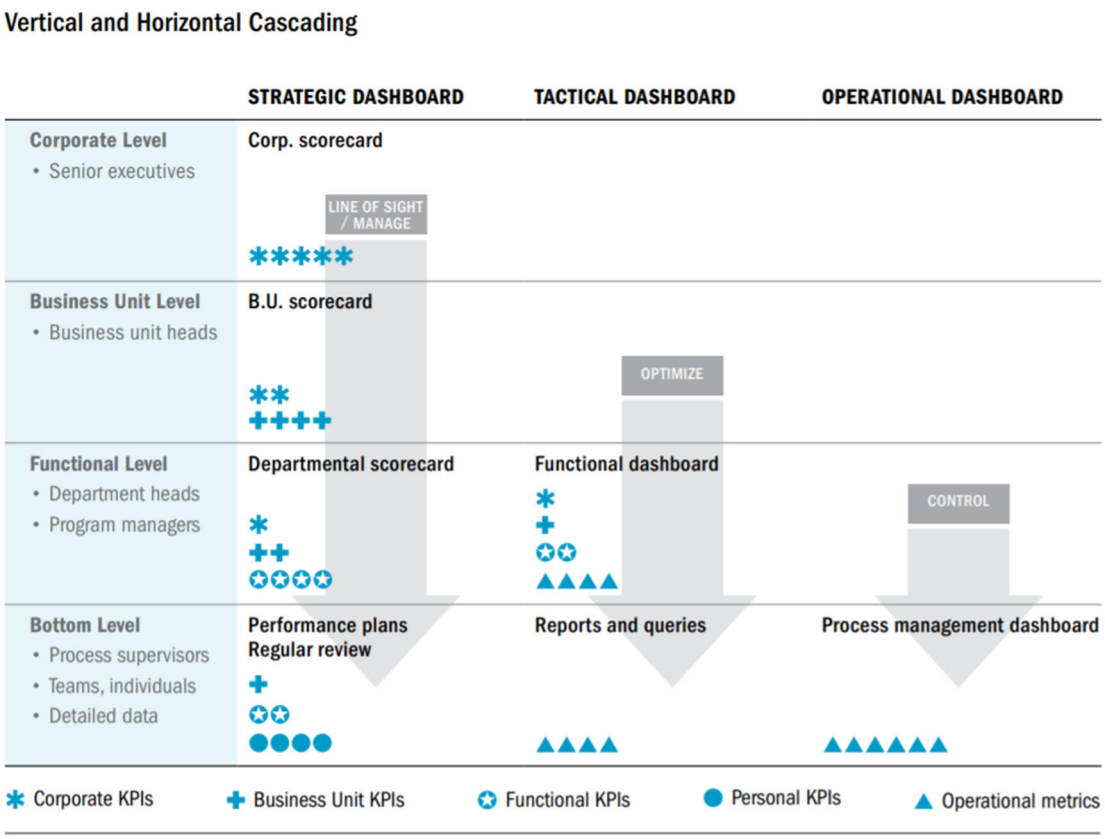

Figure 2.18: Vertical and Horizontal cascading (Eckerson, 2009:15)

Horizontal cascading, also as illustrated in Figure 2.18, aligns KPIs across different types of dashboards: strategic, tactical and operational. Horizontal cascading tries to bring together top-down initiatives that manage strategy with bottom-up dashboard projects that manage processes. Eckerson (2009:17) mentions that horizontal cascading is challenging to do because most organisations have many dashboards and scorecards that overlap and there is no guarantee that seemingly identical KPIs are defined or interpreted consistently.

Vertical cascading occurs within a single performance dashboard and among performance dashboards of the same type. KPIs within a single dashboard are tightly coupled and allow for users to drill down from summary to detail-level views of performance across many dimensions. KPIs of dashboards of the same type are loosely coupled each reflecting KPIs from a dashboard at an organisational level above it. Lower levels of an organisation usually have more KPIs than higher levels. Eckerson's (2009:15) research shows an average of 16 KPIs on the executive level, 22 KPIs on the business unit level and 24 KPIs at department and workgroup level.

This study seek to develop and model operational level performance indicators that will support the Effectiveness Score Card for Stellenbosch University. The Effectiveness Score Card for Stellenbosch University consist of performance indicators under the strategic framework on a strategic level. Chapter 4 will apply the cascading approach supported by Eckerson (2009) to develop a dashboard with operational level performance indicators for Stellenbosch University under section 4.2.

Steward and Carpenter-Hubin (2000:38) differentiate between performance indicators developed for external audiences and performance indicators developed of internal audiences. External audiences include: consumers (student and parents); governing bodies (legislators and accrediting agencies) and potential revenue providers (alumni and donors). Internal audiences include university decision makers (faculty and academic administrators). An accepted model with data framed in the context of performance on organisational goals can facilitate conversation, decision-making and the ease of implementing strategic decisions.

Ball and Wilkinson (1994:418) categorise performance indicators as: internal performance indicators (e.g. market share of undergraduate applications by subject; graduation rates and classes of degrees); external performance indicators (first destination of graduates, publications by staff and citations); and operational performance indicators (Units costs, staff/student ratios).

Parmenter (2015:3) states that not all performance measures in an organisation are key performance indicators (KPIs). Parmenter (2015:3-4) differentiate between four types of performance measures. The four types of performance indicators are grouped into Result Indicators and Performance Indicators. Result indicators (RIs), according to Parmenter, is the summation of many measures of more than one group's input. The advantage of result indicators is that it is useful to look at combined teamwork but it does not help management to

fix a problem because it is difficult to identify teams responsible for performance and teams responsible for non-performance. Performance indicators (PIs) are measures that can be linked to team or a cluster of teams, working closely together for a common purpose. Good or bad performance is then linked to the team.

A further classification is to add the word key to the measure: Key Result Indicators (KRIs) and Key Performance Indicators (KPIs). KRIs provide a broad overview of the overall summary of the organisation's performance; RIs tell management how teams are combining to produce results (a result of more than one activity); KPIs tell management on how the organisation is performing in their critical success factors and focus on a specific activity; and PIs tell management what teams are delivering and focus on a specific activity.

Performance indicators consist of several characteristics and can be classified according to different criteria depending on the area where the performance indicators are applied to measure performance. Eckerson (2009) states that performance indicators should be derived from the organisation's goals but other measures can also be included on an operational dashboard of which the organisation wants to keep track.

A review on performance indicators, the characteristics of performance indicators and the cascading of performance indicators will assist in developing an operational dashboard with operational level performance indicators for Stellenbosch University that will support strategic level performance indicators. Eckerson (2009) states that vertical cascading will provide management with a line-of-sight of performance across groups and across levels within the organisation.

2.3. Summary and Conclusion

This chapter presented a literature review on performance measurement frameworks as well as performance indicators and the cascading of performance indicators.

The chapter started with an introduction to why performance measurement and performance management are needed in organisations. Section 2.2.1 is a review on performance, performance measurement and performance management. Section 2.2.2 continued with describing popular performance measurement frameworks in literature followed by a discussion on the possible use of one or more of the performance measurement frameworks listed to measure performance at Stellenbosch University. A conclusion was made that none of the listed performance measurement frameworks can be applied at Stellenbosch University

under section 2.2.2.3, but characteristics identified (section 2.2.2.4) from the performance measurement frameworks should be incorporated into the new performance measurement framework to be developed for Stellenbosch University in Chapter 3.

Section 2.2.3 is a literature review on key performance indicators, the characteristics of performance indicators and the classification of performance indicators. Literature supports the cascading of performance indicators from a strategic level to an operational level. Chapter 4 will follow the process of identifying operational level performance indicators from data fields that already exist in the university[2] and expand the performance indicators with performance indicators identified in literature. The process of cascading performance indicators from a strategic level to operational level at Stellenbosch University with a model to visualise the performance indicators will complete Chapter 4 .

[2] Data fields for operational level performance indicators were populated with simulated data sets for all the experiments reported in this thesis.

Chapter 3

Effectiveness Score Card for Stellenbosch University

Effectiveness is the foundation of success—efficiency is a minimum condition for survival after success has been achieved.

Efficiency is concerned with doing things right. Effectiveness is doing the right things.

Peter Drucker (1986:36)

3.1. Introduction

Stellenbosch University developed a new strategic framework after the SU Institutional Intent and Strategy 2013-2018 expired (see Appendix A). Strategic Framework 2019-2024 (see Appendix B) contains six core strategic themes namely, a transformative student experience, networked and collaborative teaching and learning, research for impact, purposeful partnerships and inclusive networks, employer of choice, and a thriving SU. These themes provide a broad view of the goals of the university for the next few years, but the framework lacks the ability to provide a clear overall view of the university's performance with respect to these themes. The purpose of this chapter is to assist the university by developing a performance measurement framework that will measure the university's overall performance as well as the performance of the core strategic themes under the strategic framework.

3.1.1. Performance measurement frameworks in literature

Performance measurement frameworks have been developed over many years, and documented in literature, to assist organisations, and higher educational institutions with the increasingly difficult task to measure and manage performance. Greater expectations are being placed on higher education institutions, while governments demand increased performance. Barnett (as cited in Alexander, 2000:411) states that higher education systems have entered

"the age of disenchantment." Universities find themselves in a world economy with rapid change, intense flow of information and increasing competitiveness. Performance management and strategic planning is needed for universities to survive in the competitive environment, to increase adaptability within the environment, as well as to increase customer satisfaction and responsiveness.

Popular performance measurement frameworks listed in literature are reviewed in Chapter 2 under sections 2.2.2.1 and 2.2.2.2 and discussed under section 2.2.2.3. None of the mentioned performance measurement frameworks fit Stellenbosch University's new Strategic Framework with a clear strategy to measure performance within the university. A performance measurement framework that an organisation uses should directly relate to the organisation's strategy and therefore the need to develop a new performance measurement framework for Stellenbosch University.

The composite index approach used by Asif and Searcy (2014) for performance measurement in higher education is the nearest approach that we could find in literature that is similar in some aspects to the composite index approach we developed to measure performance at Stellenbosch University. The only similarity between the composite index approach developed by Asif and Searcy and the composite index approach we developed, is that priority weights are allocated to different levels according to the priority of the performance indicators on the different levels. Our approach was inspired by previous work on artificial neural networks and their sensitivity analysis. (Yeung, Cloete, Shi, Ng, 2009)

3.1.2. A composite index approach for performance measurement

Composite measures are a widely adopted approach for performance measurement in national health care systems. A composite measure has the ability to capture the complexity of system performance and summarise information contained in dissimilar indicators which no single indicator can do. A composite index integrates large amounts of information in an easily understood format which allows for summary assessment of performance in priority areas. (Jacobs et al., 2014:383)

Smith (as cited in Jacobs *et al*., 2014:384-385) list advantages of using a composite index as a performance measurement framework in organisations. Performance is placed at the centre when using a composite index; composite indicators offer a rounded assessment of performance; composite indicators can be rolled up (summarised) at different levels in the organisation; and facilitate communication between role players and promote accountability;

beacons of best performance as well as areas that should be a priority for improvement are highlighted in this framework; decision makers can set their own priorities and pursue improvements in areas of high priority; and composite indicators are easier to interpret than finding trends in many separate indicators. Of course this depends on the design of the measurement methodology.

The composite performance measurement framework proposed in this thesis and that of Asif and Searcy can be differentiated on the following aspects: Asif and Searcy's framework is based on four dimensions related to academic performance (research, teaching, service and financial measures) and SU's strategic framework targets specific themes and corresponding goals over a defined period. Unlike Asif and Searcy's framework, each of these themes and sets of goals (see Appendix B: a transformative student experience, networked and collaborative teaching and learning, research for impact, purposeful partnerships and inclusive networks, employer of choice, and a thriving SU), touch on aspects of research, teaching, service and finance, which makes it well-nigh impossible to distinguish these aspects within PIs from one another. Furthermore, the effectiveness framework that we propose calculates effectiveness at each level in the SU strategic framework, as well as overall effectiveness, whereas the framework from Asif and Searcy incorporate ratings (comparing the university's indicators with peer institutions' indicators on low levels) and not effectiveness within the university.

The composite index for Stellenbosch University was developed according to the following steps suggested by Jacobs *et al*. (2007):

- *Choose the entities that will be addressed.* Performance will be measured under the new Strategic Framework for Stellenbosch University.
- *Choose the institution's objectives that will be included in the composite measure.* The core strategic themes and institutional objectives under the Strategic Framework will be included in the composite measure.
- *Select the indicators that will be included in the composite measure.* The indicators and measures under the university Strategic Framework will be included.
- *Transform the measured performance of individual components.* Visualisations will be included in the model that will show actual values, targets and progress made on each of the indicators.

- *Use some sort of weighting to combine the components.* Weights will be allocated to all nodes in the tree, from core strategic themes, institutional objectives to indicators and measures according to the component's priority. Priorities are determined by University management.
- *If efficiency measures are included (related to the use of resources or cost to achieve performance measured on the composite), then adjust for variations in expenditure. This means that organisations should be given budgets that will give them equal opportunities to secure equal composite scores.* Efficiency is not directly addressed in the Effectiveness Score Card for Stellenbosch University.
- *Conduct a sensitivity analysis to test the robustness of the outcome of the composite measure to the various methodological choices.* Missing values are calculated and visualised in the model, and their contributions, as well as those of each component of the model to the overall score, are calculated to show the sensitivity of that component with respect to the overall score.

Weighting in the composite index approach allows for the combining of components and the allocation of priorities within a system. Weights are value judgements of the relative importance of the different indicators in the overall system and the relative opportunity cost of achieving those performance measures. Dimensions that are considered more important will be allocated a greater weight and greater organisational effort will be allocated to achieve better performance in these dimensions. Weights allocated to performance indicators have a profound effect on the outcome of the composite index and the change in weights in one or more of the performance indicators in which the organisation excels or fail will have a dramatic effect on the overall score of the organisation. (Jacobs *et al*., 2007:389)

The composite index approach will measure the performance of the new Strategic Framework 2019-2024 of Stellenbosch University.

3.2. Vision and Strategic Framework for Stellenbosch University

The Strategic Framework 2019-2024 (Appendix B) for Stellenbosch University is aligned with Stellenbosch University's Vision 2040 (Appendix A).

The vision statement by Stellenbosch University for 2040 (Stellenbosch University, 2020):

> *Stellenbosch University will be Africa's leading research intensive university, globally recognised as excellent, inclusive and innovative, where we advance knowledge in service of society.*

The mission statement for Stellenbosch University (Stellenbosch University, 2020):

> *Stellenbosch University is a research-intensive university where we attract outstanding students, employ talented staff and provide a world-class environment; a place connected to the world, while enriching and transforming local, continental and global communities.*

Stellenbosch University has six core strategic themes that underlie the SU Strategic Framework 2019-20204. The framework provides for further planning in the university and the details of the plan is incorporated into the annual Institutional Plan (IP) and serves to integrate and effectively coordinate SU's institutional strategy, priorities and goals. The environment plans of all the responsibility centres, faculties and professional administrative support services (PASS) are aligned with the strategic framework and the IP.

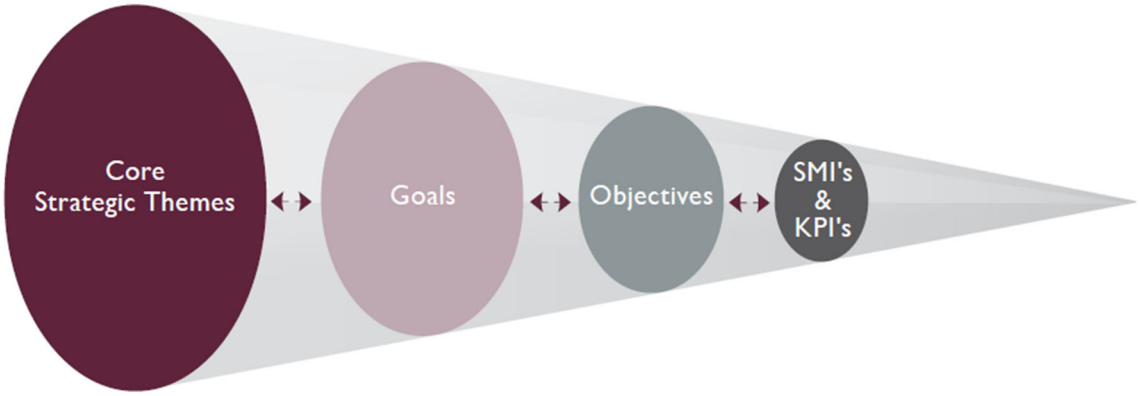

Figure 3.1: Relationship between the components of SU's Strategic Framework (Source: Stellenbosch University, www.sun.ac.za/english/about-us/strategic-documents 16 April 2020)

Figure 3.1 shows the relationship between the university's core strategic themes, the institution's goals, institutional objectives and SMI's and KPIs. SU does not refer to Key Performance Indicators but rather 'Strategic Management Indicators' (SMI's) for KPIs in the strategic framework. The university's goals are identified out of the core strategic themes and the institutional objectives, on an aggregated level, and are then further refined to identify indicators on a more granular level that are linked back to the original core strategic themes.

Figure 3.2 lists the six core strategic themes that form the strategic framework for Stellenbosch University.

Figure 3.2: SU Strategic Framework 2019-2024 – Core Strategic Themes (Source: Stellenbosch University, www.sun.ac.za/english/about-us/strategic-documents 16 April 2020)

For each core strategic theme, institutional objectives were defined, and for each such an objective, a set of indicators and measures were defined. Table 3.1 shows the layout for the core strategic theme, *Research for Impact.* The term Strategic Management Indicator (SMI) is used to refer to elements in the rightmost column, for example 5.1.1.

Table 3.1: Hierarchical structure of core strategic theme 5, Research for Impact

CORE STRATEGIC THEME	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES (SMIs)
5. RESEARCH FOR IMPACT	5.1 Support research staff and invest in capacity development	5.1.1 % of academic staff members with a doctorate to all academic staff members
		5.1.2 % of Postdoctoral Research Fellows to all academic staff members
	5.2 Increased funding for research	5.2.1 Increase research impact
		5.2.2 Average number of masters graduates per academic staff member per year
		5.2.3 Average number of doctoral graduates per academic staff member per year

A table with all the core strategic themes, institutional objectives, and SMIs as well as definitions is available in Appendix B: Stellenbosch University's Core Strategic Themes 2019-

2024 *[Source: Stellenbosch University]*. Subsequent sections in this chapter describe our proposed Effectiveness Score Card for SU.

3.3. Effectiveness Score Card model for SU

The Effectiveness Score Card models and tracks the new Strategic Management Indicators (SMIs) with respect to 2024 targets, as aligned with Vision 2040 and the Strategic Framework (SF) for Stellenbosch University.

The Effectiveness Score Card is based on a composite index approach, with the purpose to measure progress for each SMI, objective and theme, as well as for the SF as a whole. Different weights are allocated to core strategic themes, institutional objectives and indicators and measures, which all influence the overall composite effectiveness of the university.

Performance measurement is complex and the allocation of weights to performance indicators (PIs) according to their priorities to derive a composite score require the participation of key stakeholders. The Effectiveness Score Card was discussed with and demonstrated to the rectorate on 31 March 2020 where the model was accepted as a novel management tool for Stellenbosch University.

3.3.1. Graphical representation

Figure 3.3 is a tree diagram visually representing a hierarchical structure of the performance indicators at Stellenbosch University. The University overall represents level 0, measuring performance at an institutional level, followed by level 1, the core strategic themes (CST), then level 2, the institutional objectives, and at level 3 the indicators and measures. Only CST 5 is further expanded in the figure to illustrate the tree structure, which of course applies to all of them.

By assigning weights to the branches of the tree, a performance measure can be calculated for each SMI and at every level, as well as for the overall performance of the university at level 0. For each SMI a target has been set, against which the value obtained for a particular year is compared, to derive a performance measure for that year.

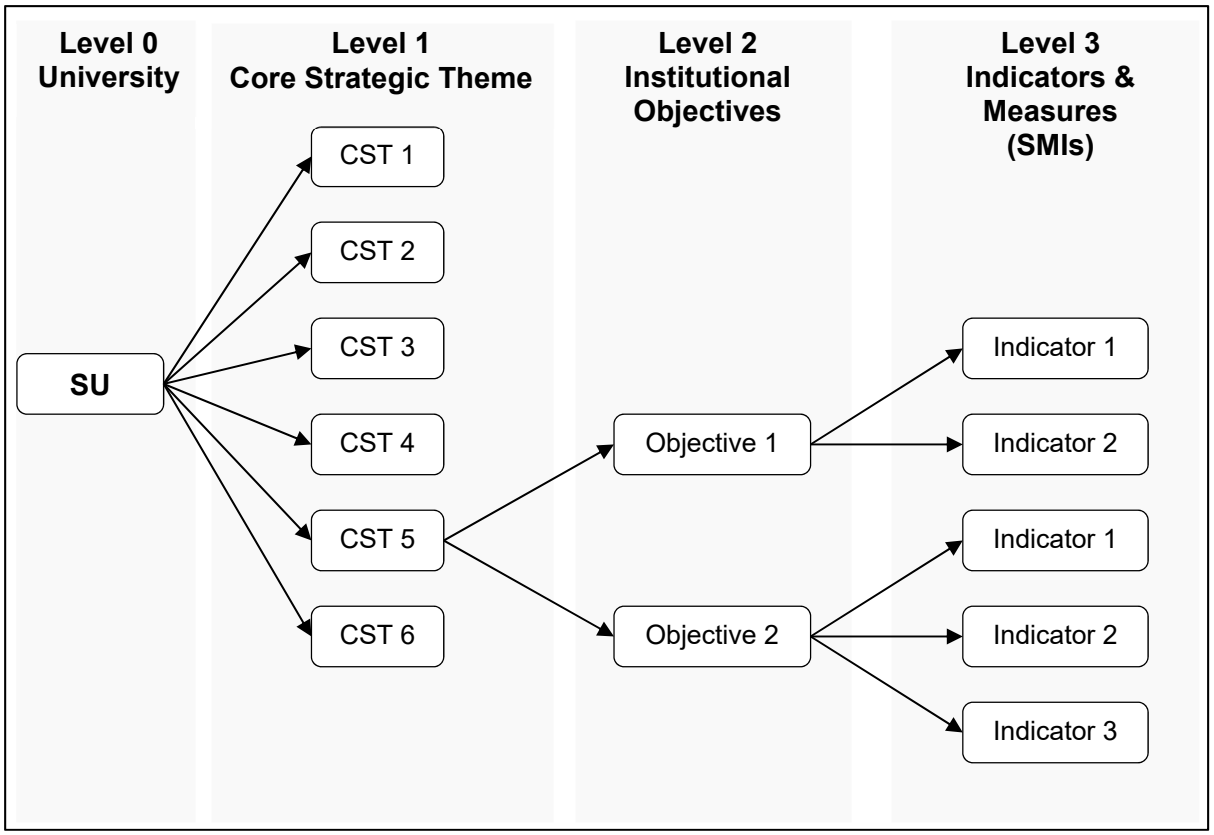

Figure 3.3 A tree diagram visually representing the hierarchical structure of performance indicators at Stellenbosch University with specific reference to CST 5

3.3.2. Historical data in the Effectiveness Score Card model

The Effectiveness Score Card model starts with line chart visualisations for available historical values and targets. Figure 3.4 is a printed screen from the visualisation software (MS Power BI™) of the core strategic theme *Research for Impact*. The core strategic theme, *Research for impact* consists of two institutional objectives: (1) Support research staff and invest in capacity development and (2) Increase research impact as seen in Figure 3.4. The institutional objectives are further divided into indicators and measures. The indicators and measures for the institutional objective (1) includes: % of academic staff members with a doctorate to all academic staff members; and % of Postdoctoral Research Fellows to all academic staff members as seen in Figure 3.4 on the left of the printed screen. The charts on the printed screen consist of historical values for the indicators and measures, indicated with a blue line on the chart and targets set by the university for several years for the indicators and measures and visualised with a yellow line.

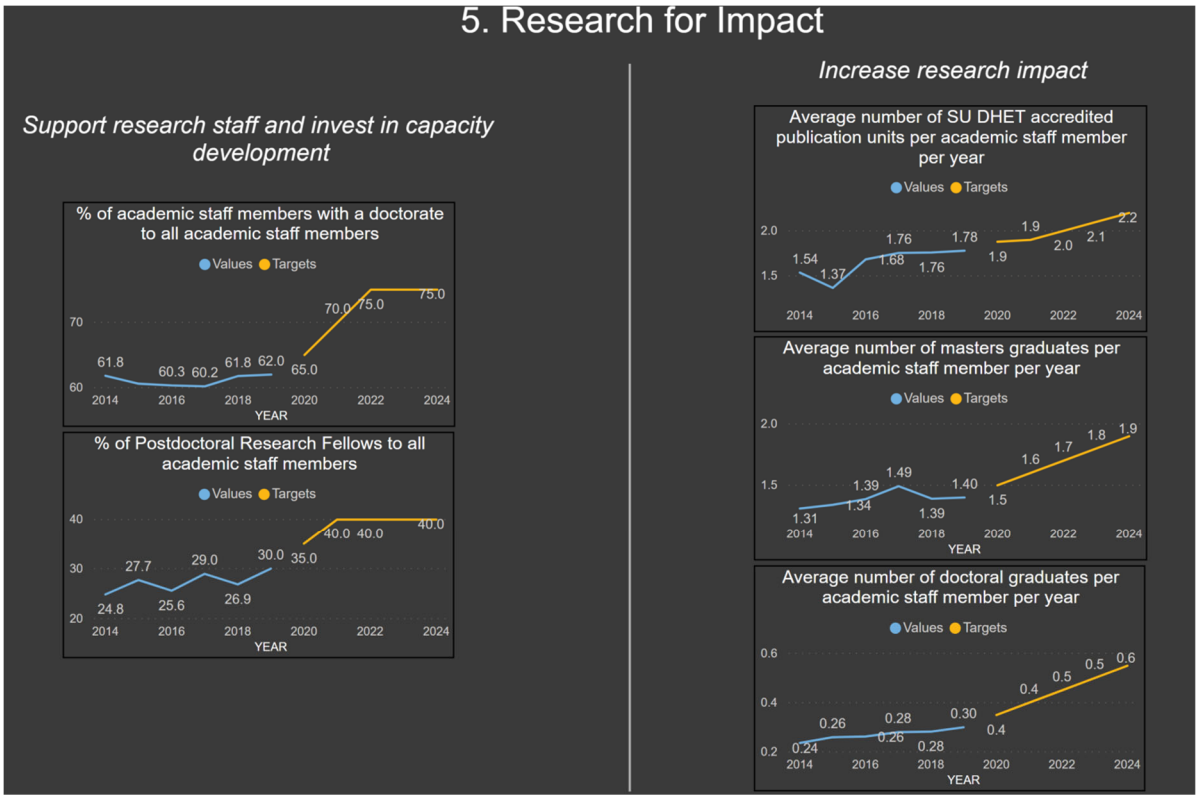

Figure 3.4: A printed screen from MS Power BI™ software of historical values and targets for indicators and institutional objectives of SMI 5, Research for Impact, in the effectiveness score card model[3]

Indicators and measures have values from 2014-2019 and targets from 2020-2024. Some indicators and measures in other SMIs do not have values for some years; some indicators and measure in other SMIs do not have targets for all the years, except for 2024 where all indicators and measures, except SMI 4, have targets.

3.3.3. Performance Indicators in the Effectiveness Score Card model

Performance Indicators (PIs) are visualised with Radial Gauge charts in the Effectiveness Score Card model. Figure 3.5 indicates the two types of radial gauge charts that are used in the model, positive radial gauge charts and negative radial gauge charts. The reason for the positive and negative radial gauge charts was because some of the indicators and measures should be maximised, for example throughput rate. However, other indicators and measures should be minimised (or should not exceed the target value), for example lower expenses are encouraged in contrast to higher expenses.

[3] Institutional permission was obtained to use the University's data.

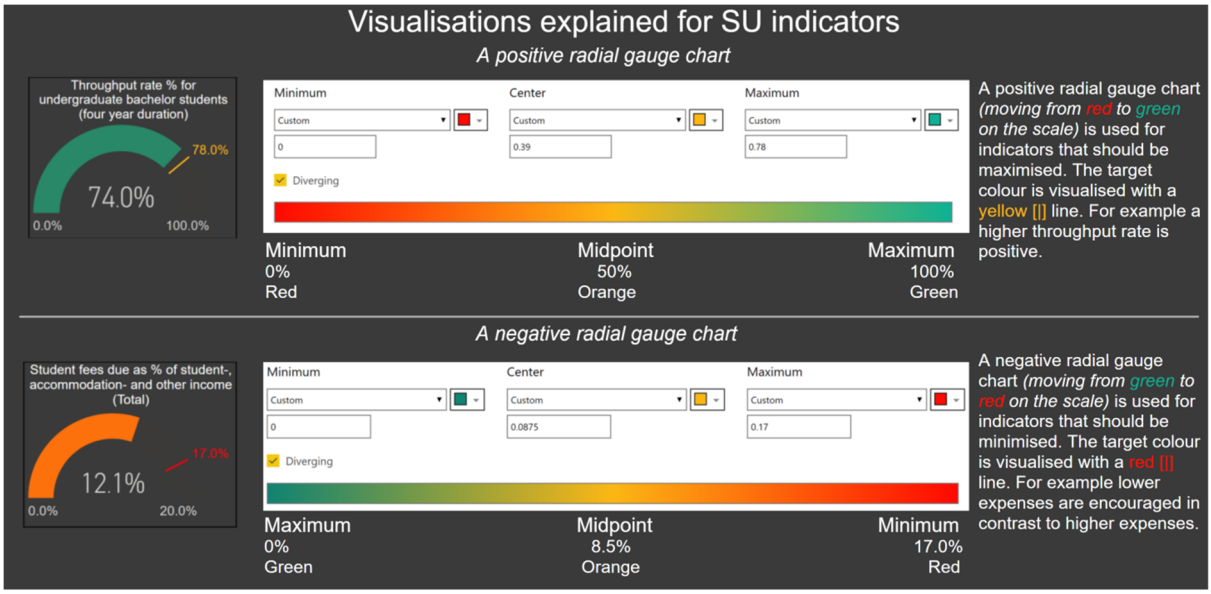

Figure 3.5 Positive and negative radial gauge charts in the model

Microsoft.com (2020) defines radial gauge charts as follow: "A radial gauge chart has a circular arc and shows a single value that measures progress toward a goal or a Key Performance Indicator (KPI). The line (or needle) represents the goal or target value. The shading represents the progress toward that goal. The value inside the arc represents the progress value."

Eckerson (2009:7) emphasise the importance of applying consistent encoding to KPIs. The user should connote the same performance values when looking at graphical displays on performance dashboards. All the conditional formatting translate into the same values, e.g. above target, on target, or below target translates into red, orange and green colour encodings. The red, orange and green colour encodings are also known as the traffic light colour encoding in charts where the colours are used to indicate mitigation action status or risk impacts, depending on items defined by the project. Green in model and in the gauge charts indicates a positive action, e.g. a higher throughput rate of undergraduate bachelors students will be represented by a darker green the higher the throughput rate. A lower throughput rate, closer to zero percent will move from green (which will represent a good score), to orange (which will indicate a warning signal) to red colour encodings which will indicate risk and that actions are needed for the specific indicator and measure.

Figure 3.6 is a printed screen showing PIs in the Effectiveness Score Card model for core strategic theme, *A Thriving Stellenbosch University*.

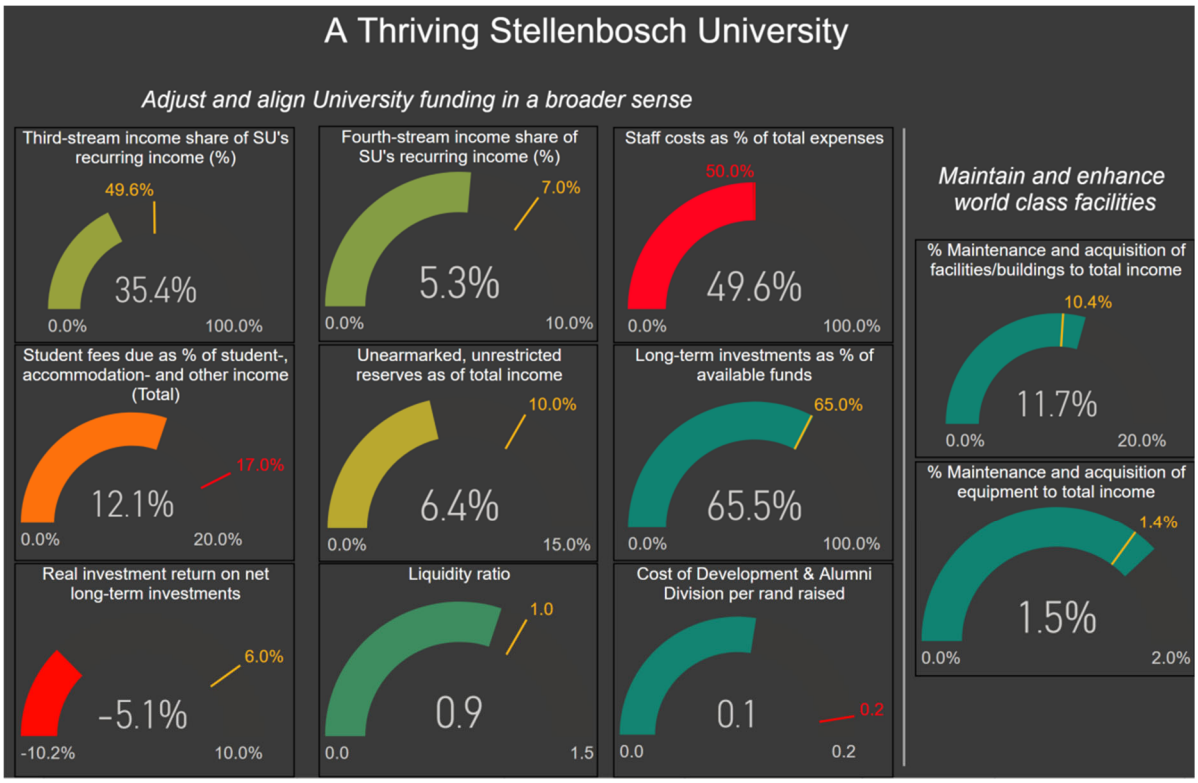

Figure 3.6: A printed screen of core strategic theme, A Thriving Stellenbosch University in the effectiveness score card model[4]

Eckerson (2009:7) differentiate between five types of targets:

1. *Achievement*. Achievement is when performance should reach or exceed the target and anything over the target is valuable but not required. Achievement in our model means that SMIs that reach their targets and go above their targets will receive a performance score of a 100%. *Third-stream income share of SU's recurring income (%)* under CST, *A Thriving Stellenbosch University*, and institutional objective, *Adjust and align University funding in a broader sense* is an example of an SMI that should be maximised and is indicated with a positive radial gauge chart in the model. Thirty-six out of the forty-one SMIs (excluding CST 4) in the SU's Strategic Framework should be maximised and represent the vast majority of SMIs.
2. *Reduction*. Reduction is when performance should reach the target or be below the target. The SMI, *Staff costs as % of total expenses* under CST 1, *A Striving Stellenbosch University* is an example of a SMI with a reduction type target.
3. *Absolute*. Absolute is when performance should be equal to the target but not above or below the target. None of the SMIs on the SF can be categorised under this category.

[4] Institutional permission was obtained to use the University's data.

4. *Min/Max*. Performance should be within a range of values to be a Min/Max type and anything above or below the range is not good. The SMI, *Cost of Development & Alumni Division per rand raised* under the CST, *A Striving Stellenbosch University* is an example of an SMI with a Min/Max type target. Costs incurred to raise funds are inevitable but should not exceed the given target. The target set by the university for the SMI Cost of Development & Alumni Division per rand raised, should be less than 19 cents (<R0.19).
5. *Zero*. Performance should be the minimum value possible. Debtors are an example of these types of SMIs in our model. The SMI *Student fees due as % of student-, accommodation- and other income (Total)* under the CST, *A Thriving Stellenbosch University*, is the only SMI on the SU strategic framework that in theory can have a 0 value and be 100% effective, but it is highly unlikely in real life for a university to have no student fees outstanding for a year, and therefore any score below the target will receive a positive effectiveness score, and a value equal or above the target will receive an effectiveness score of 0% because universities want to manage outstanding fees for the university's financial health.

Performance indicators were only created for 2018 values (not all of 2019's data are available at the time of writing) against 2024 targets, but more years can be added to the model as soon as we obtain the data.

3.3.4. From Performance Indicators to Effectiveness Measures in the Effectiveness Score Card model

Performance Indicators, as discussed in the previous section, are visualised with Radial gauge charts showing the progress of the indicators towards the target.

Figure 3.7 shows how effectiveness is calculated by dividing the value by the target from the performance indicator in the model to get to an effectiveness measure.

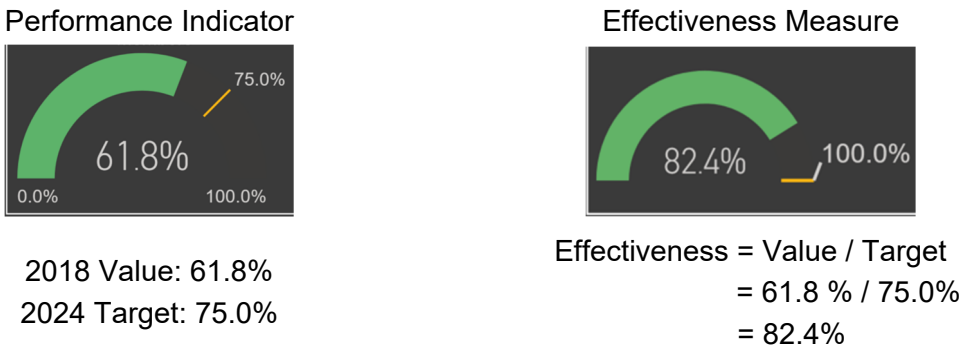

Figure 3.7: The calculation of effectiveness in the effectiveness score card model

Definition: Effectiveness is the calculation of the extent to which the target is reached.

PIs with an effectiveness score of above 100% is capped at 100% and PIs with an effectiveness score of less than 0% is capped at 0%. A PI cannot be less effective than 0% or more effective than 100%, i.e. $0 \geq$ Effectiveness ≤ 100. A composite index on the different levels in the framework is the sum of products of only non-negative numbers in the range from 0 to 100%, i.e. the sum is a monotonically increasing number. The framework measures the contribution of each performance indicator independently. If a negative number is permitted in the effectiveness calculation then it will decrease the sum. This will violate the monotonically increasing characteristic and independence of indicators, because it decreases the effectiveness of the other indicators participating in the sum. For example, suppose the effectiveness of two indicators are summed; one is at 100%, the other at -10%. The sum is 90%, where it should have been 100% if negative effectiveness is not allowed.

Effectiveness measures can be calculated for multiple years. In the examples shown here effectiveness measures were calculated for 2018 values against 2024 targets as well as for 2019 values against 2024 targets.

3.3.5. Creating a composite effectiveness measure by awarding different weights to performance indicators according to their priorities

Composite Effectiveness is addressed in the Effectiveness Score Card model by allocating weights to performance indicators according to the performance indicator's priority.

Literature shows that PIs can be categorised more effectively according to the university's key priorities. (Asif & Searcy, 2014:985) It is thus necessary to prioritise indicators according to the needs of the institution. Composite measures are valued for their ability to integrate large amount of information into easily understood formats and facilitate judgement on overall system performance. Composite measures also provide the possibility to view performance at different levels in the university and over time. (Smith as cited in Jacobs *et al*., 2014:384-385)

Composite effectiveness measures were created in the Effectiveness Score Card model by adding different weights to performance indicators according to the priorities of the indicators. Different weights for different performance indicators are variable parameters of the model which influence composite measures, which in turn influence the university's overall performance.

Three model versions with different weight combinations for different performance indicators are presented to show the influence on the university's overall performance. The first version is named 'Vanilla_1' (Figure 3.8), the second version is named 'Vanilla_2' (Figure 3.9) and the third 'DiffWeights' (Figure 3.10). 'Vanilla_1' has an equal weight distribution across all performance indicators (meaning all core strategic themes have the same priority); 'Vanilla_2' has an equal weight distribution across all performance indicators except for CST 4 with 0% due to no values and/or targets allocated to this CST (meaning all core strategic themes have the same priority except for CST 4); and 'DiffWeights' has different weight distributions across the performance indicators on all levels (meaning all PIs have different priorities in the university) where the levels are: Level (1) CSTs; level (2) institutional objectives; and level (3) SMIs.

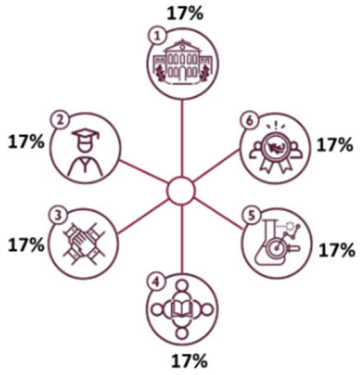

Figure 3.8: Equal weights for all CSTs
'Vanilla_1'

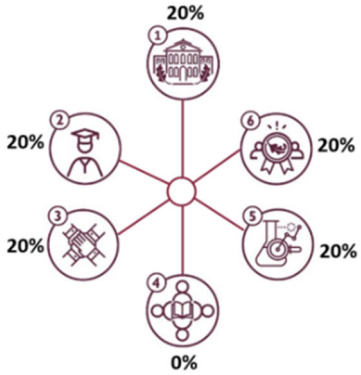

Figure 3.9: Equal weights for CST 1, 2, 3, 5 & 6. CST 4 = 0%
'Vanilla_2'

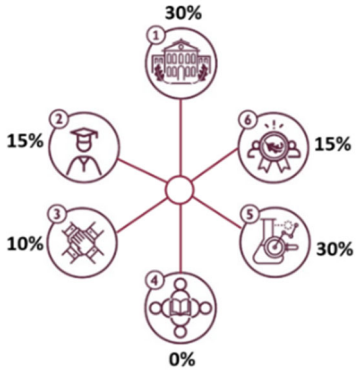

Figure 3.10: Different weights for all CSTs according to their priority
'DiffWeights'

Figure 3.8, Figure 3.9 and Figure 3.10 illustrate the different models indicating different weight allocations with different priorities as described in the previous paragraph. Note that the figures show rounded numeric values, but sufficient accuracy is used in computations.

The weights allocated to 'Vanilla_1' are divided equally among all the CSTs (meaning all core strategic themes have the same priority). This means that the six CSTs are awarded 16.67% each to add up to 100% for the core strategic themes. The weights of the institutional objectives (second level performance indicators) are then further divided equally depending on the number of institutional objectives and weights on the third level performance indicators, the indicators and measures, are also divided equally to add up to 100% per institutional objective. Figure 3.11 is a breakdown of core strategic theme, *Research for Impact*, with equal weights allocated to the different indicators down the tree.

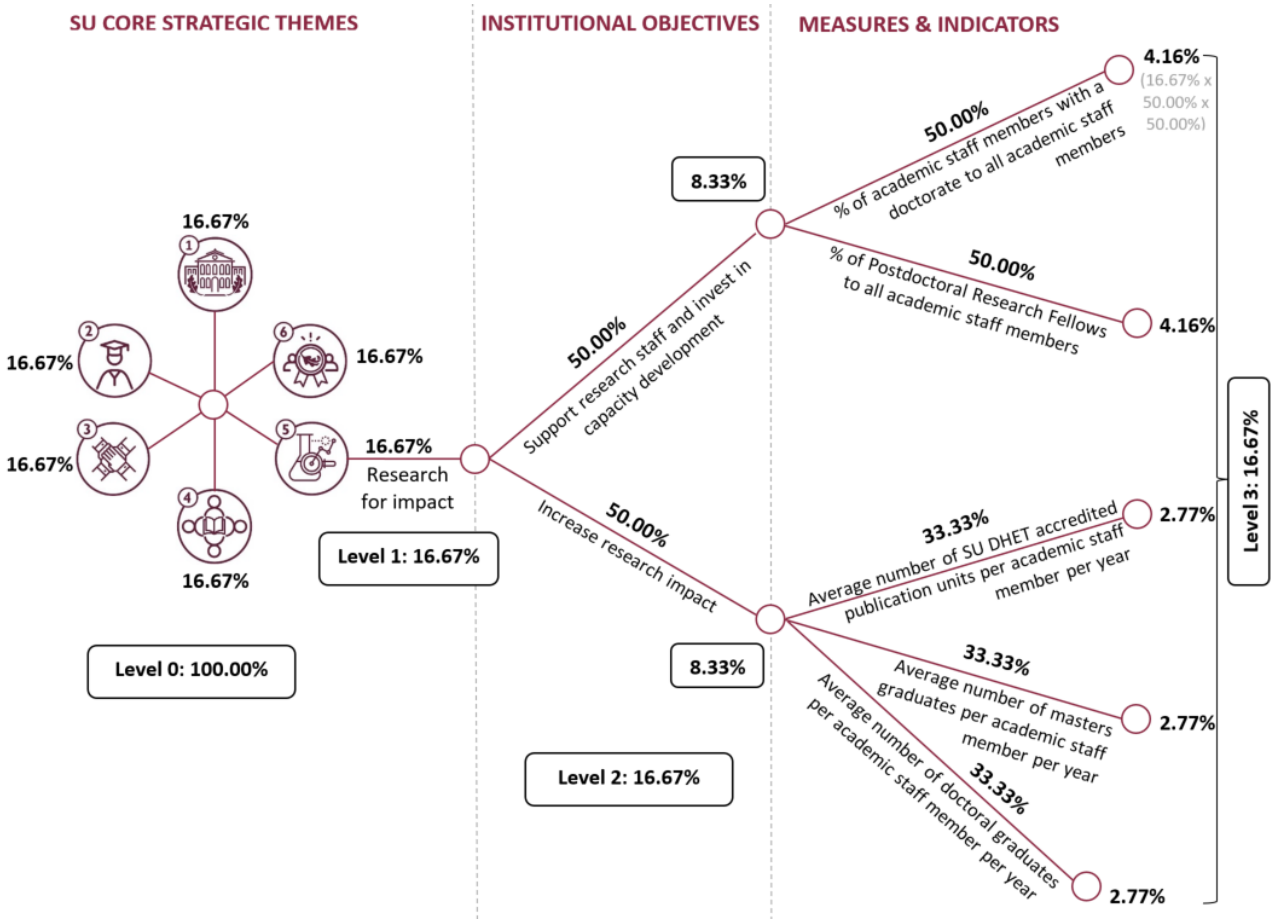

Figure 3.11: Breakdown of CST, Research for impact, indicating the weight distribution of the PIs

Every indicator and measure contribute to the combined overall SU Core Strategic Themes as indicated in Figure 3.12.

Different weight allocations to performance indicators have an impact on the composite effectiveness measures of the university.

The measure and indicator *% Of academic staff members with a doctorate to all academic staff members* in Figure 3.12 contribute 4.16% to the overall composite index of the university if the weights are equally distributed to all indicators down the tree.

For example: *Research for impact* contributes 16.67% (rounded) out of 100% to all the SU Core Strategic Themes. *Research for impact* consist of two institutional objectives: (1) *Support research staff and invest in capacity development* and (2) *Increase research for impact* which both contribute 50% each to *Research for Impact*. Institutional objective (1) *Support research staff and invest in capacity development* consists of two SMIs: (1) *% of academic staff members with a doctorate to all academic staff members* and (2) *% of Postdoctoral Research Fellows to*

all academic staff members for which both contribute 50% to the specific institutional objective.

Thus: 16.67% x 50% x 50% = 4.16%

The contribution of the indicators and measures will change when the weights are distributed according to different priorities which will have an influence, at the end, on the composite effectiveness measure.

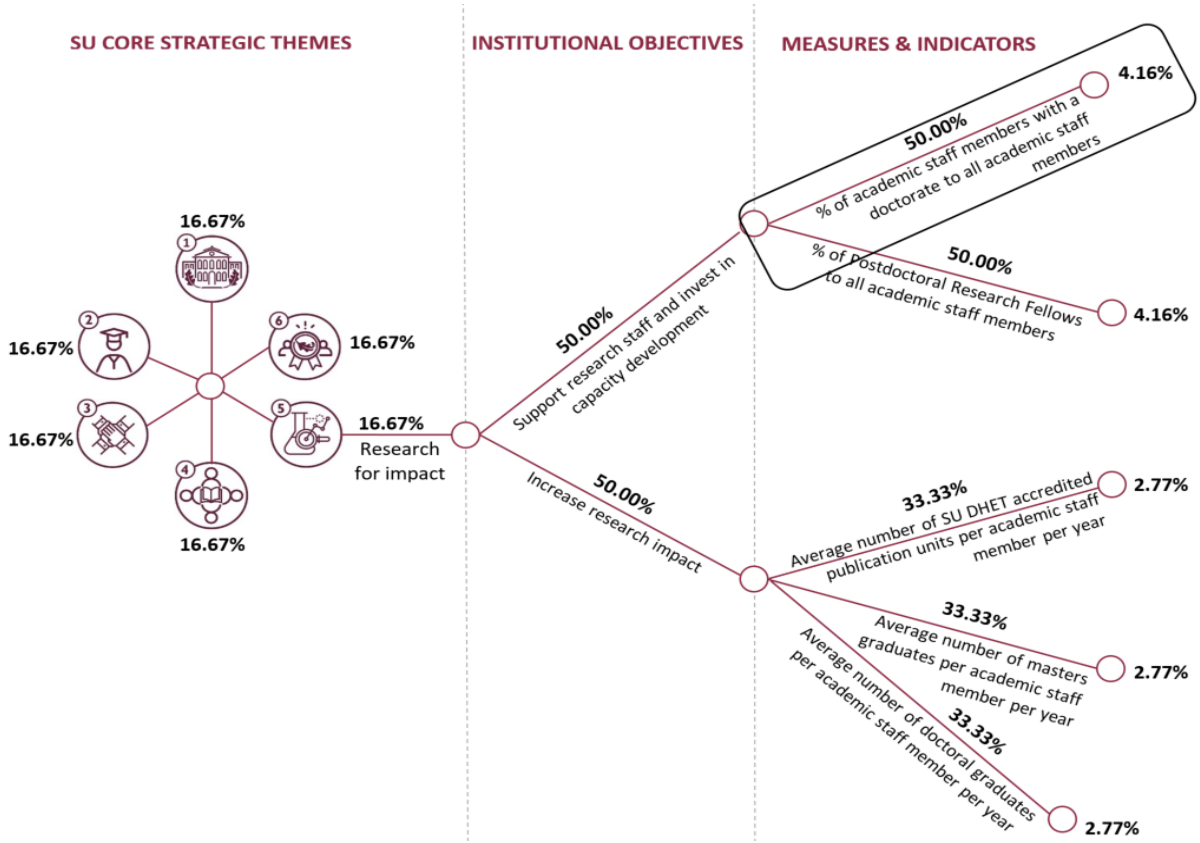

Figure 3.12: Contribution of PIs to the overall US strategic framework

A critique from Smith (as cited in Jacobs *et al*., 2014:385) on the use of a composite index is that the weights attached to each performance indicator is crucial for the composition of the composite measure. Our approach to the composite index is to allocate weights in a systematic way to the performance indicators down the tree that reflects the priorities of the performance indicators. There is no need for any calibration in the calculations we use which is an advantage of our composite index approach.

Figure 3.13 shows an example of the model 'DiffWeights' indicating different weight distributions among the different performance indicators.

The measure and indicator *% of academic staff members with a doctorate to all academic staff members* contributes 6% to the overall composite index in Figure 3.13: 30% x 40% x 50% = 6%

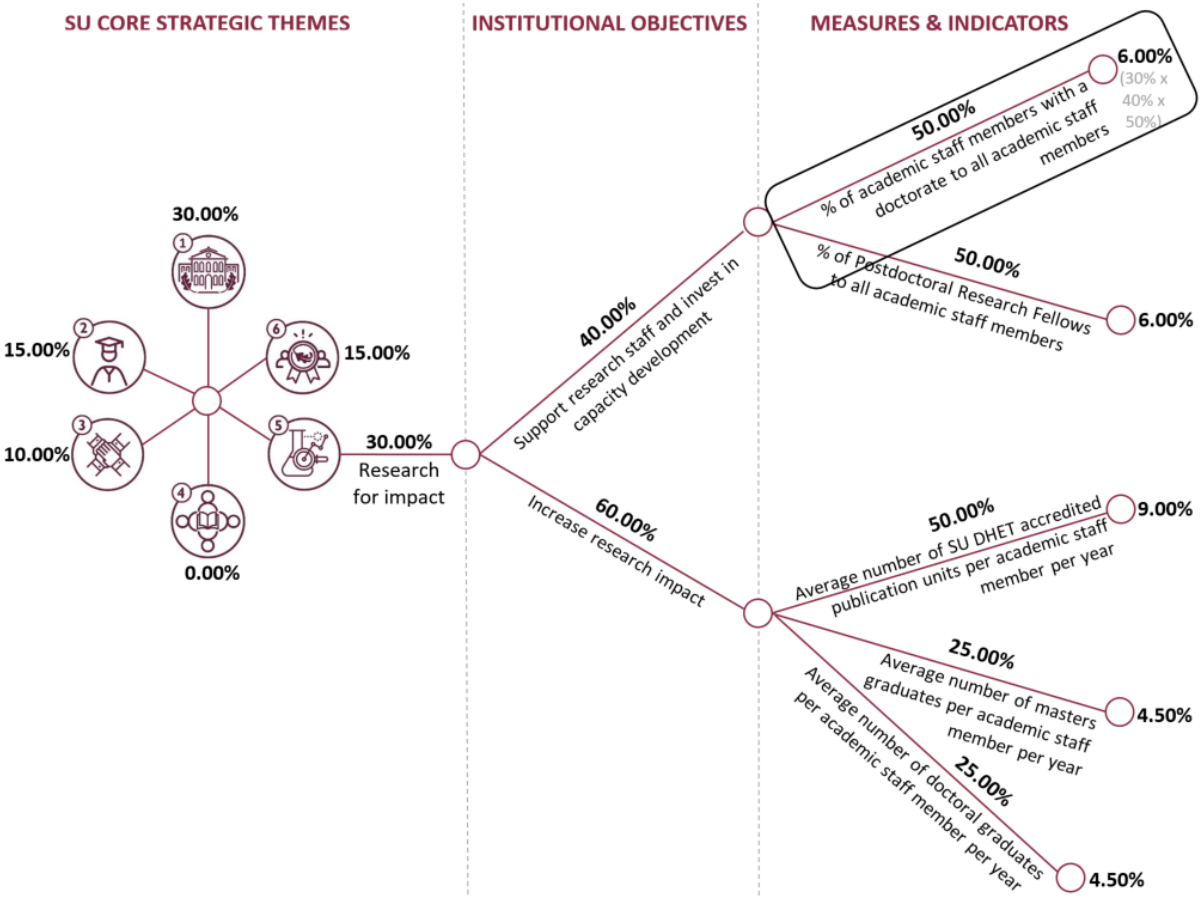

Figure 3.13: DiffWeights model with different weight distribution for PIs meaning PIs have different priorities in the university

Composite effectiveness can now be calculated by using the contribution of the indicators and measures and multiplying the contribution with the effectiveness of the performance indicator. Effectiveness is the extent to which a target is reached (Value ÷ Target), expressed as a percentage.

Figure 3.14 is an example of 'Vanilla_2', with SCT, *Research for Impact*, where all the CSTs were allocated equal weights (meaning all core strategic themes have the same priority), except for CST 4 with 0%. The institutional objectives and indicators and measures, were also weighted equally down the tree. The indicator and measure *% of academic staff members with a doctorate to all academic staff members* contributes 5% to the overall composite index in Figure 3.14 (20% x 50% x 50% = 5%).

Effectiveness was calculated by dividing the value by the target (82.4% for *% of academic staff members with a doctorate to all academic staff members*) and the composite effectiveness of this indicators and measure will then be the contribution of the effectiveness (82.4% x 5% = 4.1%). The contribution of the indicator and measure *% of academic staff members with a doctorate to all academic staff members* in Figure 3.14 is 4.1% out of 5%.

Composite effectiveness measures have the ability to be rolled up to an overall effectiveness score for the university or to look at lower levels of effectiveness in the institutional framework as indicated in Figure 3.14.

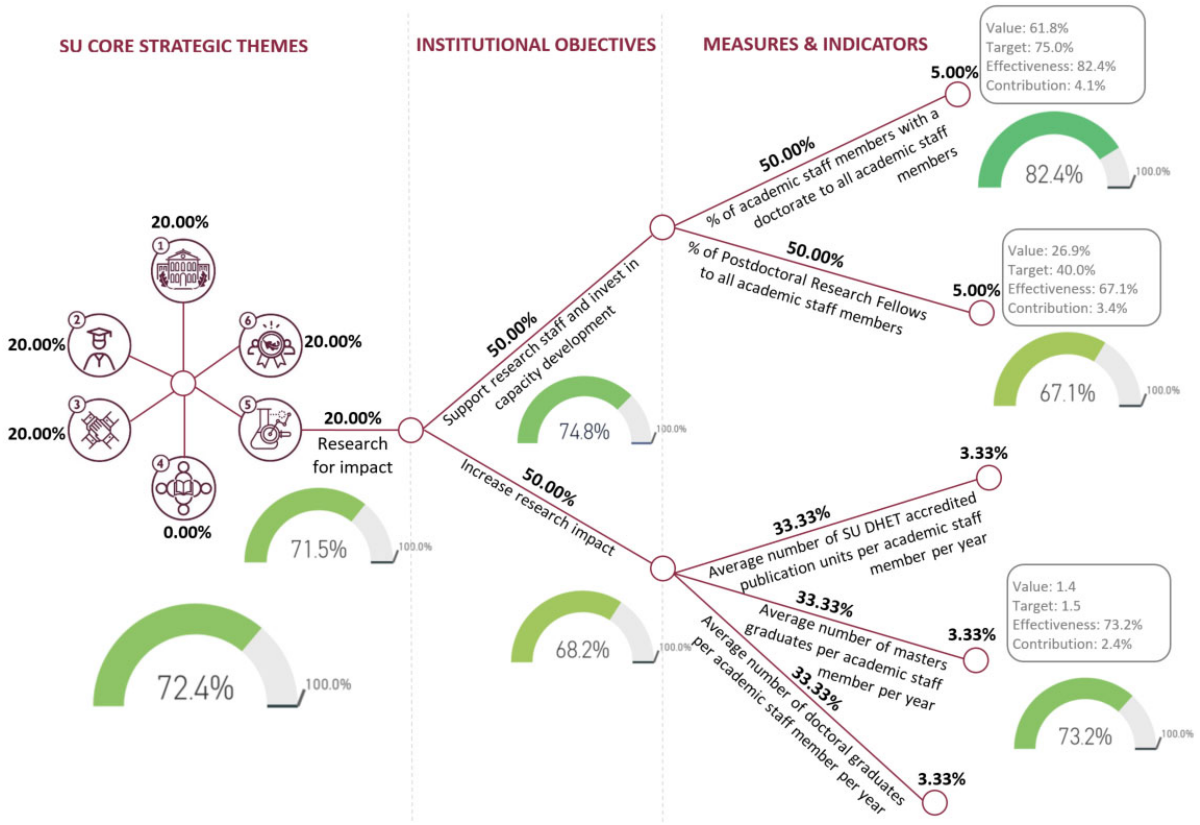

Figure 3.14: Visual presentation of Vanilla_2 where all the SMIs were allocated equal weights (meaning all core strategic themes have the same priority), except for SMI 4 with 0%

Figure 3.14 is a visual presentation of 'Vanilla_2' model using 2018 values and 2024 targets with equal weights allocated to all performance indicators down the tree (meaning all core strategic themes have the same priority) except for CST 4 with 0% weight. Figure 3.14 shows 72.4% on the overall effectiveness for the university on 2018 values, 71.5% effectiveness for CST, *Research for Impact*, 68.2% effectiveness for institutional objective *Increase Research Support* and 73.2% effectiveness for the measure and indicator *Average number of masters graduates per academic staff member per year*.

Figure 2.15 is a visual presentation of the 'DiffWeights' model showing different weights allocated to the different core strategic themes (meaning different priorities for different PIs).

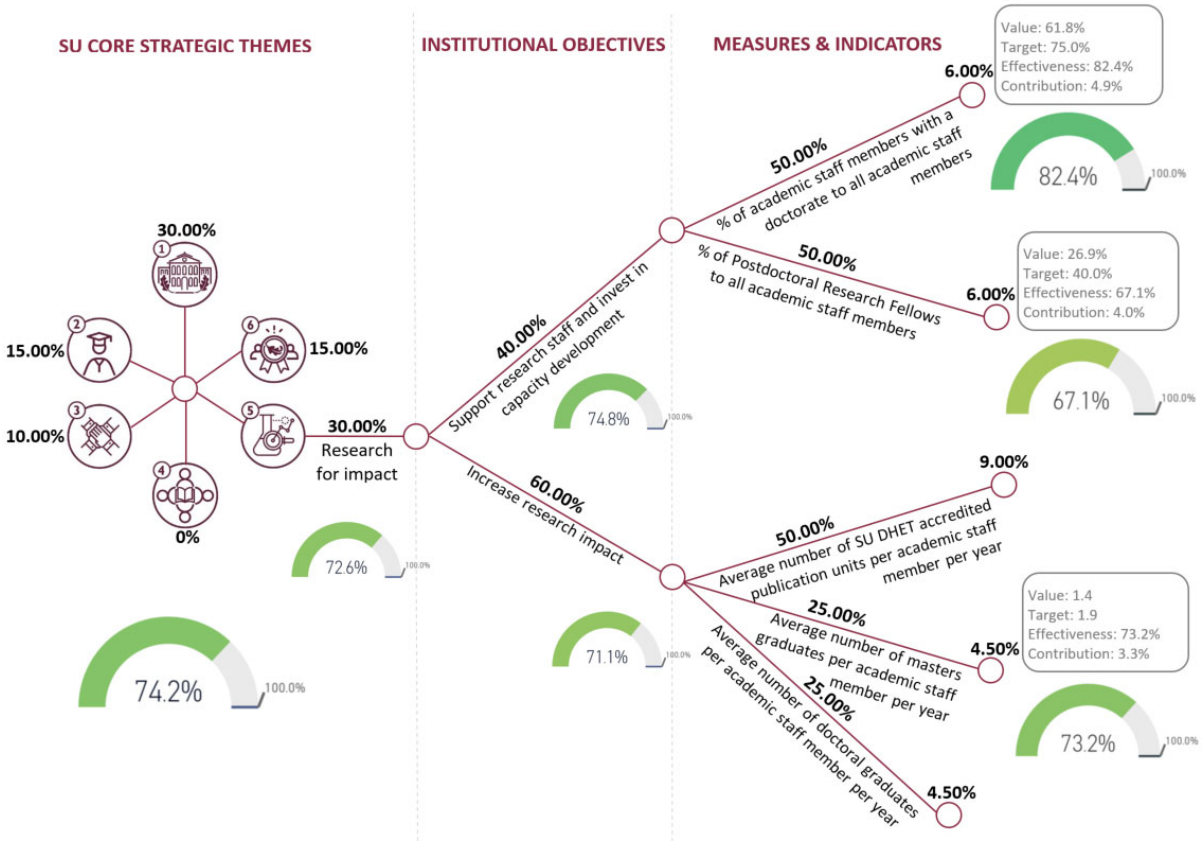

Figure 3.15: DiffWeights model with different weights allocated to the PIs (meaning different priorities for different PIs).

Table 3.2 compares the composite effectiveness of 'Vanilla_2' and 'DiffWeights' at different levels in the university, indicating that different weight allocations (meaning different priorities) for different performance indicators have an influence on the composite effectiveness in the university.

Table 3.2: Comparison of composite effectiveness between 'Vanilla_2' and 'DiffWeights'

EFFECTIVENESS LEVEL IN THE UNIVERSITY	***Vanilla_2***	***DiffWeights***
Overall Effectiveness for the University	72.4%	74.2%
Effectiveness for CST: *Research for Impact*	71.5%	72.6%
Effectiveness for institutional objective: *Increase Research Support*	68.2%	71.1%
Effectiveness for the SMI: *Average number of masters graduates per academic staff member per year*	73.2%	73.2%

Composite effectiveness measures were used in the model to provide a broad picture of the performance of the university along the university's key priorities as well as to evaluate effectiveness over time.

Figure 3.16 is a printed screen image from 'Vanilla_2', with equal distribution of weights for performance indicators (meaning all PIs have the same priority) except for CST 4 with 0% weight, evaluating the composite effectiveness of the CSTs using values from 2018 measured against 2024 targets as well as 2019 values measured against 2024 targets. The blue bars are composite effectiveness measures from the 2018 values and 2024 targets and the yellow bars are composite effectiveness measures form the 2019 values and 2024 targets. Figure 3.16 shows 72.4% on the overall effectiveness for the university on 2018 values and 71.5% effectiveness for CST 5, *Research for Impact*. In other words, Stellenbosch University has made 72.4% progress overall on the goals that were set within the Strategic Framework 2019-2024.

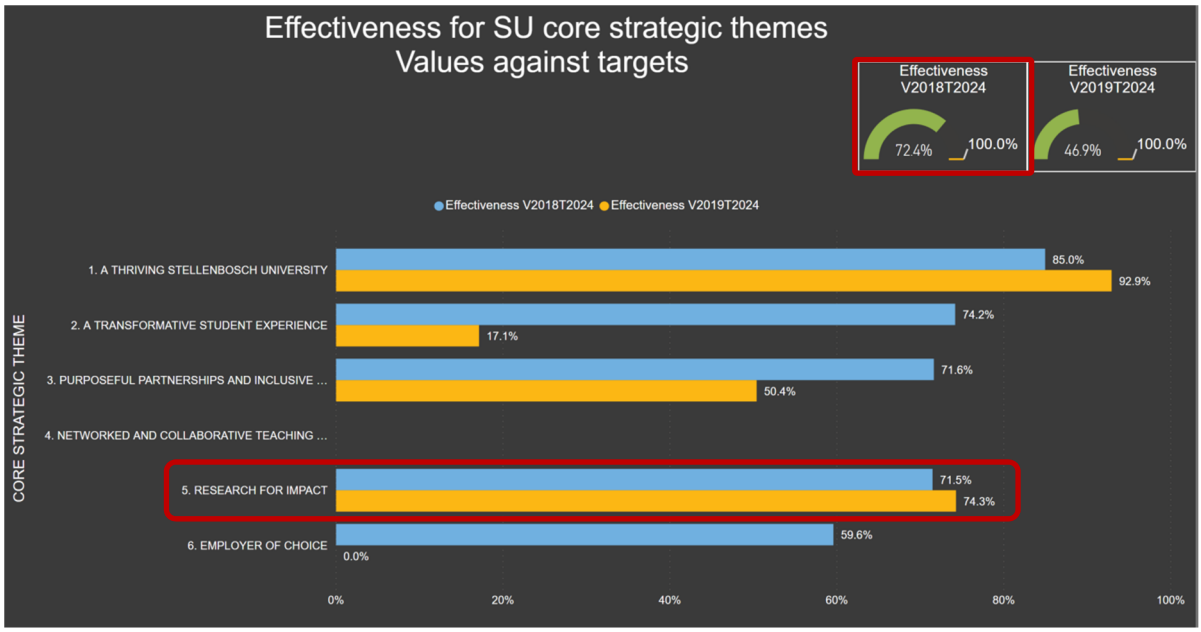

Figure 3.16: Printed screen image from 'Vanilla_2' showing overall performance of the university as well as performance for the CSTs.

Figure 3.17 is a print screen from the 'DiffWeights' model where different weights were allocated to the different indicators according to priority as follows. CST 1: 30%; CST 2: 15%; CST 3: 30%; CST 4: 0%; CST 5: 10% and CST 6: 15%. The blue bars are composite effectiveness measures from the 2018 values and 2024 targets and the yellow bars are composite effectiveness measures form the 2019 values and 2024 targets. Figure 3.17 shows 74.2% on the overall effectiveness for the university on 2018 values and 72.6% effectiveness

for CST 5, *Research for Impact*. In other words, Stellenbosch University has made 74.2% progress overall on the goals that were set within the Strategic Framework 2019-2024.

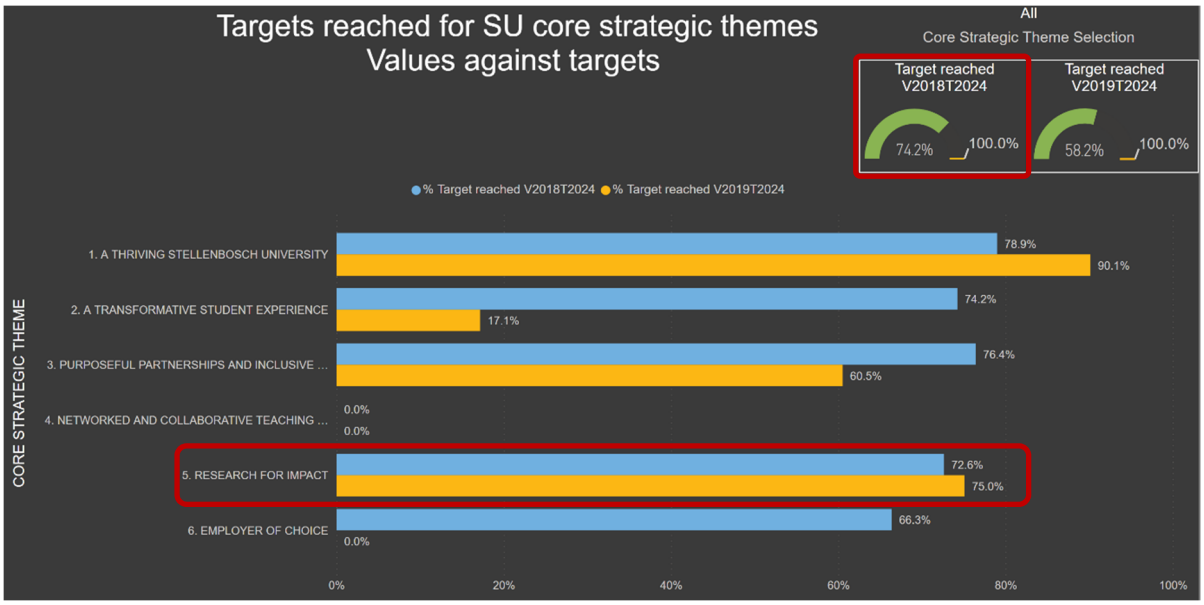

Figure 3.17: Printed screen image from 'DiffWeights' showing overall performance of the university as well as performance for the CSTs

Figure 3.18 is a printed screen image from 'Vanilla_2' showing 68.2% effectiveness for institutional objective *Increase Research Support* and 73.2% effectiveness for the measure and indicator *Average number of master's graduates per academic staff member per year*.

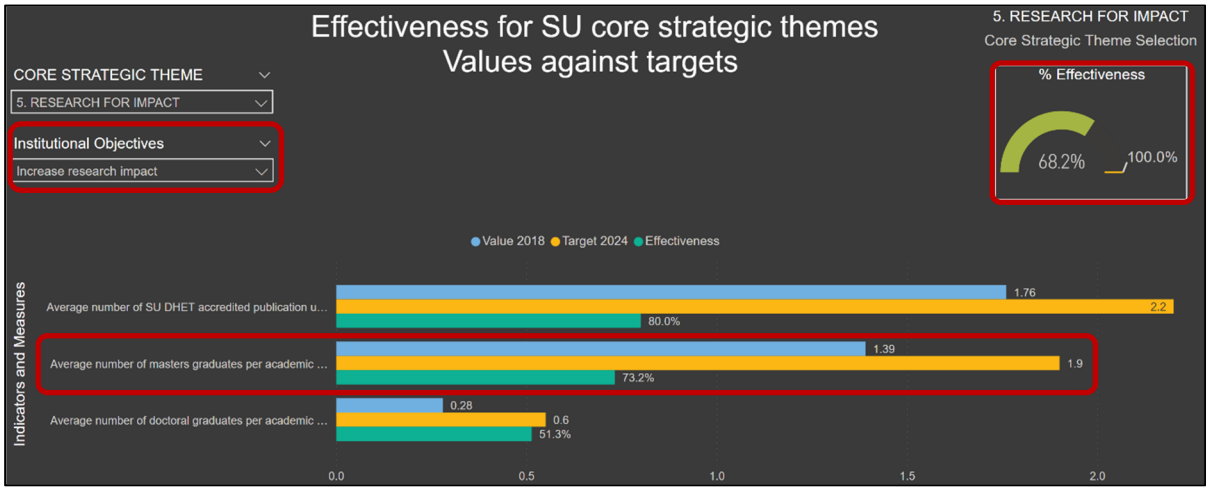

Figure 3.18: Printer screen from 'Vanilla_2' showing effectiveness for institutional objective 'Increase Research Support' as well as indicators linked to the institutional objective 'Increase Research Support'

It is clear from the previous images that different weight allocations to different performance indicators influence composite effectiveness in the university on different levels.

3.3.6. Missing values

Jacobs *et al*. (2007:385-386) list eight steps in creating a composite measure and the last step is to conduct a sensitivity analysis to test the robustness of the outcome of the composite measure. Missing values in our model influence effectiveness on all the levels.

The SMI *Number of alumni hubs, clubs and special interest groups (RSA and internationally)* under CST 3, *Purposeful Partnerships and Inclusive Networks*, has no value allocated for any of the years and only a target for 2024; and CST 4: *Networked and Collaborative Teaching and learning* has no values or targets for any years as yet. These missing values are treated as zeroes, i.e. a zero effectiveness score, which is also propagated up the tree when computing composite scores. The missing values can be addressed in the MS Power BI™ model by filtering out the SMIs with no values. The only downside of using filters to remove records is that the user has to remember to remove the filters when new data becomes available and the dataset is updated.

However, there is another solution to address the missing values in the model without filtering out the SMIs with no values. The contribution of missing values can be identified and shown on different levels in the model. The effect of missing values can be calculated by adding the contribution of the SMIs with no values, which can then be shown on different levels for accurate interpretation of each SMI's contribution to effectiveness in the score card.

3.1.6.1. Addressing missing values in the model.

Figure 3.19 is a visual presentation of 'DiffWeights' with particular reference to CST, *Purposeful partnerships and inclusive networks*. 'DiffWeights' have different weight distributions across the PIs on all levels (meaning all PIs do not have equal priorities as in 'Vanilla_2').

Every node in the tree in Figure 3.19 (as well as the rest of the model) represents a 100% contribution to effectiveness at that node, and when a node splits into different branches, e.g. the three institutional objectives under CST, *Purposeful partnerships and inclusive networks*, then the sum of the branches (weights allocated to the different branches) of a single node must add up to 100%.

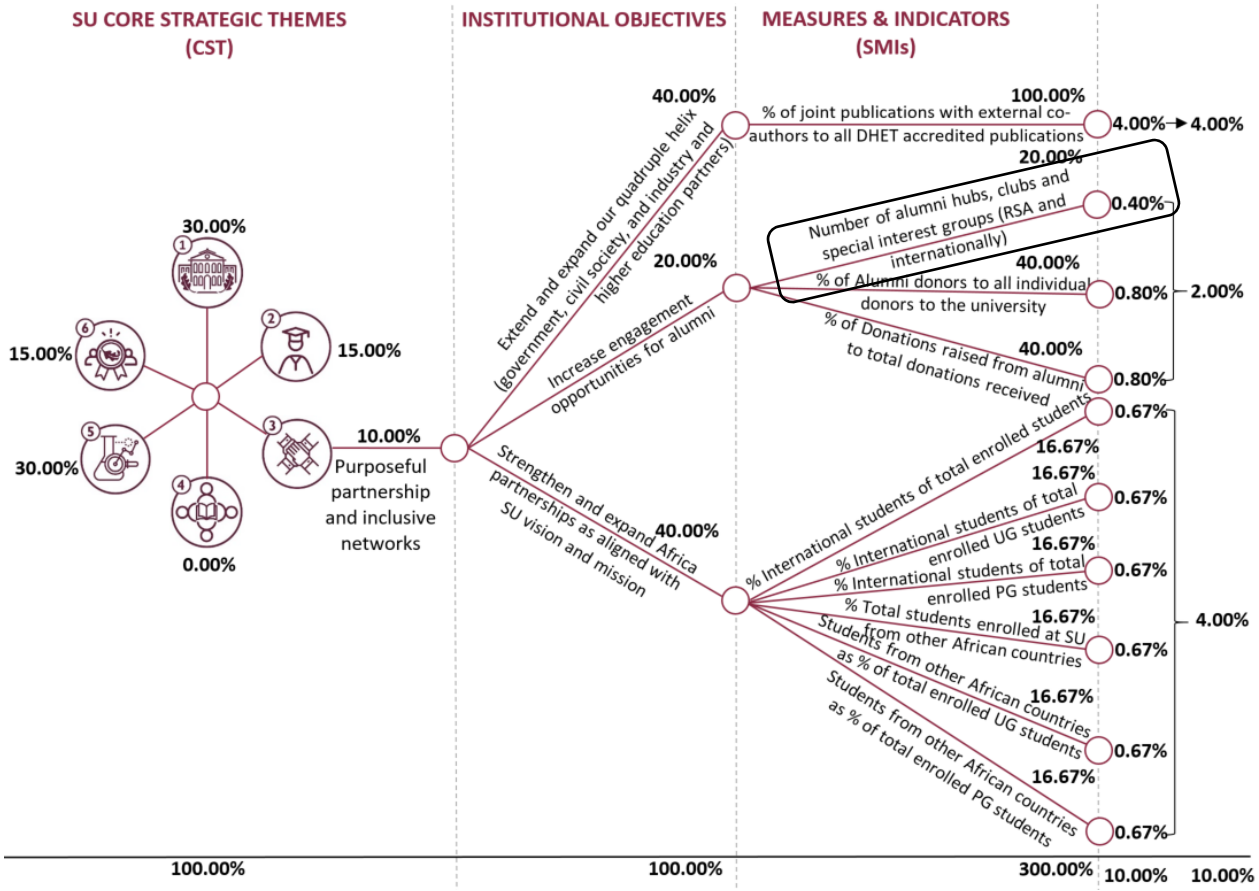

Figure 3.19: Weight allocations for CST: Purposeful partnerships and inclusive networks

The sum of the three SMIs under the institutional objective *Increase engagement opportunities for alumni* in Figure 3.19 also add up to 100%. The sum of all the SMIs under CST 3 adds up to 300%. The totals of the institutional objectives and SMIs will always be multiples of a 100 in the model. The last node in the tree represents the contribution of the SMI to the overall composite index of the university as explained in Figure 3.12. The contribution of the SMI *Number of alumni hubs, clubs and special interest groups (RSA and internationally)* in Figure 3.19 is 0.4% (10% x 20% x 20% = 0.40%)

The SMI, *Number of alumni hubs, clubs and special interest groups (RSA and internationally),* under the CST, *Purposeful partnerships and inclusive networks,* has no values for 2018 or 2019 in the model as explained under heading 3.3.6 above. Effectiveness cannot be calculated for SMIs with no values and are treated as zeros in the model which is also propagated up the tree when computing composite scores. *Number of alumni hubs, clubs and special interest groups (RSA and internationally)* will contribute 0 to the composite index for the university but has the potential of contributing 0.40% in the 'DiffWeights' model. The composite index

calculated for 2018 values against 2024 targets could have been anywhere between 74.2-74.6% for the overall university score if the SMI had a value of 0-100% allocated for 2018.

Figure 3.20 is a printed screen indicating that SMI *Number of alumni hubs, clubs and special interest groups (RSA and internationally)* has no value for 2018 as well as no effectiveness score for 2018 values and 2024 targets. The *% Contribution of PIs with no values* in Figure 3.20 indicates the total contribution of the missing values to the composite score. This means that the effectiveness for the institutional objective *Increase engagement opportunities for alumni* could have been between 71.8% and 72.2% if the SMI *Number of alumni hubs, clubs and special interest groups (RSA and internationally)* had a value for 2018 between 0-100%.

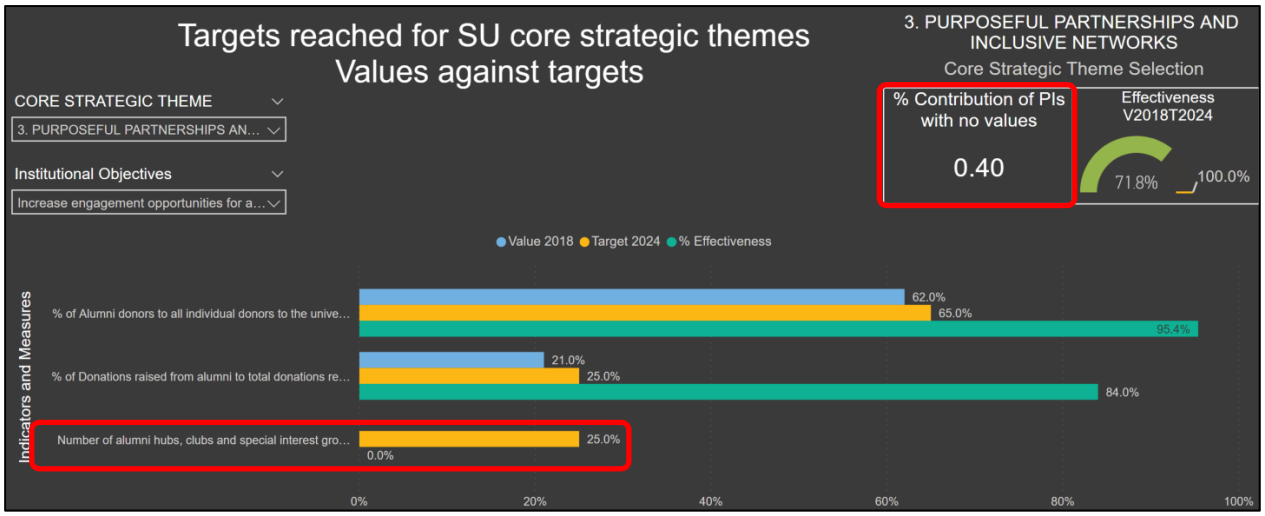

Figure 3.20: Contribution of SMIs with no values for 2018

Eighteen out of the forty-one SMIs, excluding CST 4, have no values for 2019. Figure 3.21 is a printed screen from the 'DiffWeights' model indicating overall effectiveness for the university as well as effectiveness for the CSTs for two years; effectiveness calculated by using 2018 values against 2024 targets; and 2019 values against 2024 targets. Weights allocated in the 'DiffWeights' model are: 30% for CST 1, 15% for CST 2, 10% for CST 3, 0% for CST 4, 30% for CST 5 and 15% for CST 6. Only one SMI has no value for 2018 and 18 SMIs have no values for 2019 looking at CSTs 1-3, 5 and 6. Figure 3.21 indicates that the contribution of indicators with missing values to the composite index for 2018 is 0.4% and the contribution for 2019 is 31.67%. (Refer to Figure 3.12 that illustrates the composition and contribution of performance indicators in the model.)

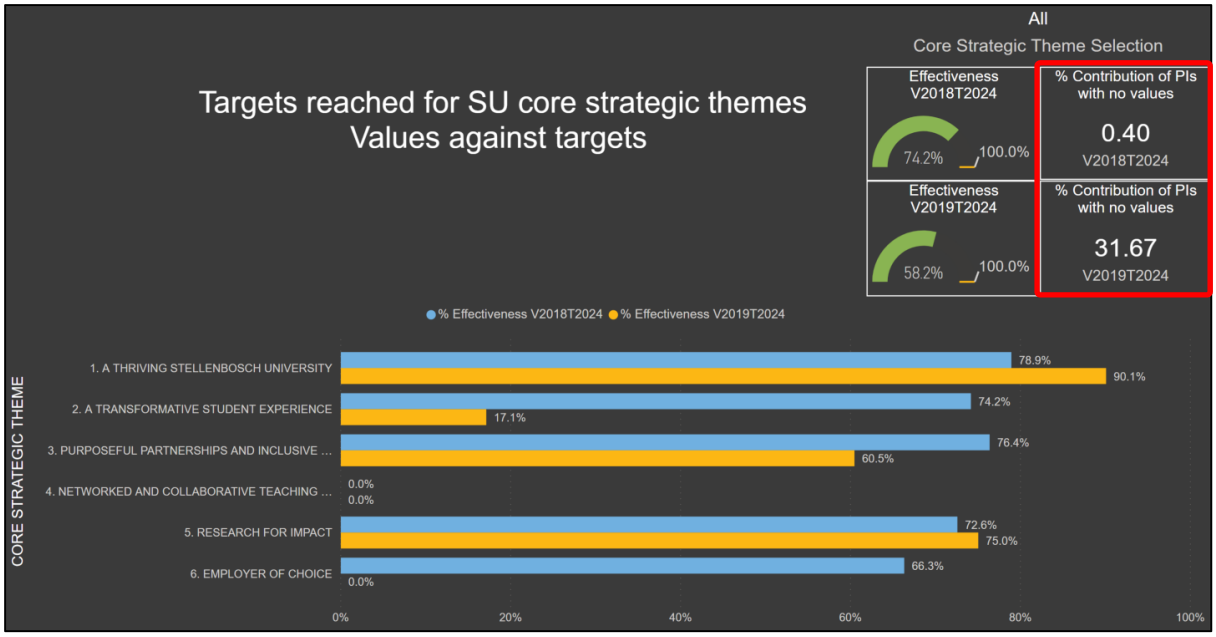

Figure 3.21: Printed screen from DiffWeights indicating the % contribution of the SMIs with no values

The overall performance for 2018 can be between 74.2% and 74.6% if the SMI with the missing value for 2018 is updated, and the overall performance for 2019 can be between 58.2% and 89.87% if all SMIs with missing values are updated for 2019. The percentage contribution of SMIs with missing values shows on all the levels in the model, level 1 - CSTs, level 2 - institutional objectives, and level 3 - SMIs in the university and will automatically update as soon a new data becomes available and uploaded into the model.

In this section we illustrated that missing values can be addressed in two ways, option one is to filter out the SMIs with missing values in the software, or option two is to calculate and show the percentage contribution of the SMIs with no values. Option two is the better solution because as soon as data becomes available and uploaded in the model, the performance and percentage contribution with missing values are updated automatically. Option one will require the user to remember to remove the filter options of the SMIs that are updated with values when new data becomes available.

3.4. Summary and Conclusion

Effectiveness and composite effectiveness are both addressed in the Effectiveness Score Card model which will assist management in measuring performance at Stellenbosch University.

Effectiveness was addressed and calculated by dividing values by targets for the different measures and indicators and composite effectiveness measures were created by allocating

weights to performance indicators according to the performance indicators' priorities. The score card also quantifies the contribution of each node in the tree relative to others and to the root node, which is the overall effectiveness score. Composite effectiveness provide a broad picture of the performance of the university along the key dimensions of the institution as well as at lower levels. Composite effectiveness can also be evaluated over time.

Smith (as cited in Jacobs *et al*., 2014:385) criticise composite indicators on the fact that composite indicators may disguise serious failing in parts of the system when aggregating individual performance measures and it might be difficult to determine the source of poor performance as measures become aggregated. The algorithm we developed for the composite index does not have the disadvantage mentioned by Smith. The algorithm we use allows us to move down the tree and identify nodes on different levels with poor and excellent performance.

The unique contribution of this study is the development of a composite index performance measurement approach based on well-defined definitions for effectiveness scores on different levels within the SF. We could not find any other composite index approach that follow the same methodology proposed in this thesis. Other composite index approaches compare KPIs against peer institutions and provide ranking scores for the KPIs which are then calibrated to be incorporated into the composite index calculations, which makes that approach difficult to follow. Our approach does not need any calibrations for values in the formula, and effectiveness can be ascribed directly to the performance of SMIs using actual values and actual targets for the SMIs in the university. The composite index allows us to view performance on different levels of aggregation and do comparisons over multiple years. Different weights allocated to the different levels in the tree allow decision makers to prioritise certain areas in the university. Provisions are also made for SMIs with missing values in the model and decision makers can identify the percentage contribution of SMIs with no values for a specific year on each of the three different levels. In addition, the measurement model proposed can be generalised to any size tree, provided effectiveness can be calculated at each leaf of the tree.

Section 2.2.2.4 listed key characteristics identified from literature to be incorporated into the performance measurement framework proposed in this chapter for Stellenbosch University. The Effectiveness Score Card model proposed for Stellenbosch University: will provide a balanced picture of the organisation, with financial and non-financial measures; the framework will provide a clear overview of the organisation's performance; all areas of performance will be reflected because it is already included in university's strategic framework; the framework is comprehensive; performance measure is integrated across the organisation's functions and

Chapter 4 will discuss the cascading of performance indicators from a strategic level to an operational level within the university; results and their drivers are measured under the strategic framework and finally, non-core measures will be evaluated in Chapter 4 to be included on an operational level.

Priorities are set in the performance measurement framework by allocating weights to performance indicators. Performance indicators concerned with inputs, activities and outputs are measured according to a time frame in the proposed model; and visualisation techniques are used in the model which will assist in the judgement of performance.

The performance measurement framework developed for Stellenbosch University is in line with key characteristics of performance measurement frameworks listed in literature.

Chapter 4 will investigate the possibility to develop an operational dashboard for Stellenbosch University with operational level performance indicators to support the strategic level performance indicators used for the university's Strategic Framework.

Chapter 4

From strategic level performance indicators to operational level performance indicators

4.1. Introduction

Stellenbosch University developed a strategic framework independently from performance indicators used in the past and no distinction has ever been made between higher and lower level performance indicators in the university. We want to investigate the possibility to add second level or operational level performance indicators in an operational dashboard that will support strategic level performance indicators in the university. The operational level performance indicators will consist of data and/or performance indicators that are already used within the university and then evaluate, expand and align the existing performance indicators with selected indicators from literature. We also want to align these performance indicators with the university's strategic management indicators.

Cloete (July 2018) suggested that the university utilises two levels of KPIs, KPIs on a strategic level and KPIs on an operational level. Cloete proposed desirable properties of SMIs (including the ability to break down to lower organisation levels, availability of historical data, must be manageable, etc.) and that lower level operational KPIs must support SMIs.

Section 4.1.1 looks back at the previous strategic framework and section 4.1.2 at the development of the new strategic framework. Section 4.1.3 discusses literature views on the cascading of performance indicators from a strategic level to an operational level.

Section 4.2 investigates the possibility of using existing data within the university to compile operational level performance indicators, linking operational level performance indicators to one of the core strategic themes under the strategic framework and calculating effectiveness at an operational level.

Section 4.3 will evaluate the performance indicators identified for the operational level dashboard against performance indicators listed in literature and identify characteristics listed in literature for performance indicators. Section 4.4 will conclude the chapter with a summary of the main findings.

4.1.1. SMIs under the previous strategic framework

The previous strategic framework for Stellenbosch University "Institutional Intent and Strategy 2013-2018" (Stellenbosch University, 2020), consisted of three strategic priorities: Broadening access, Sustain momentum on excellence, and Enhance social impact. Five strategic themes emerged out of the strategic priorities and 16 SMIs. The 16 SMIs have targets on a strategic level for the university as a whole. Out of the 16 SMIs, 10 SMIs have values on faculty and department level and 2 SMIs have values only on faculty level. The SMIs under the previous strategic framework thus have the ability to 'break down' on faculty and department level where possible.

4.1.2. Development of the new strategic framework

The new strategic framework was developed independently from the previous strategic framework with a new approach of integrated planning and execution to ensure an agile, adaptable and a responsive organisation. Although the new strategic framework was developed independently it is still compatible and do align with the previous strategic framework. (Stellenbosch University, 2020)

The new strategic framework provides for 6 core strategic themes, 11 institutional objectives and 41 SMIs with values and targets only for the university as a whole on a strategic level.

4.1.3. KPIs on a strategic and operation level for the new strategic framework

Cloete (July 2019) suggested that the SMIs for the new strategic framework should include the following characteristics: the SMARTER criteria as well as have historical data available, the ability to 'break down' and be measured on different levels of detail, and lastly be manageable. The SMARTER criteria stands for: Specific, Measurable, Attainable, Relevant, Time-bound, Explainable and Relative.

The 'break down' characteristic, to be measured on different levels of detail means that the indicator must be measured on university, faculty and/or department level where possible. The SMIs under the new strategic framework were only developed on a strategic level.

The SMIs under the previous strategic framework were on a strategic and an operational level and this chapter propose to create performance indicators on an operational level for new strategic framework with specific reference to the core strategic theme, *Research for impact* as an example.

4.1.3.1. Literature supports KPIs on a strategic and operational level

Literature supports the use of performance indicators on a strategic and on an operational level in an organisation. The CUC Report (2006:1) suggest the use of high-level KPIs on a strategic level supported by lower-level KPIs in each of the high-level performance areas of an organisation. Zhu (2014) mentions that an effective way to track the achievement of strategic goals is to cascade the strategic KPIs down throughout the organisation with the use of operational KPIs. Higher level KPIs should be tied to the next lower level KPIs so that drill down is possible to see which component of the top level KPI is off target. Operational level metrics should be tied directly to achieving strategic goals so that every employee knows how their role fits in to achieve the desired strategic outcomes. Lower level operational metrics nearly always falls hierarchically under some higher level general goal.

Eckerson (2009:13-14) agrees with Zhu that KPIs cascade from higher levels to lower levels in the organisation. Eckerson states that KPIs cascade in aligned organisation from strategic dashboards to tactical and operational dashboards. Eckerson (2009:12) disagrees with Zhu on the use of operational level metrics. It is important, according to Eckerson, to include some operational metrics on operational dashboards, even if they do not directly tie back to a strategic goal or roll up to a KPI on a strategic level. Plenty of operational processes should be tracked because if they break or something goes wrong then management should know about it. Eckerson (2009:6) differentiate between standard metrics and strategically aligned metrics. Metrics refer to the measurements of business activity and strategically aligned metrics, also known as key performance indicators measure performance aligned with the business strategy. KPIs measure performance against a goal and embodies strategy.

We propose to develop a dashboard with operational level performance indicators and metrics to support strategic level performance indicators for Stellenbosch University.

A single core strategic theme is identified under section 4.2.1 to create operational level performance indicators as an example for this study.

4.2. Operational level KPIs for the university

4.2.1. KPIs for a single core strategic theme on the strategic framework

We chose the core strategic theme, *Research for impact,* to develop supporting operational level KPIs as an example of operational level KPIs, because it is clear from the following statements that research is one of the main focuses of Stellenbosch University.

Prof Wim de Villiers, Rector and Vice-Chancellor of Stellenbosch University made the following statement where SU's new Vision 2040 and Strategic Framework 2019-2024 was launched on 24 July 2018: “Our vision is to become Africa's leading research-intensive university, globally recognised as excellent, inclusive and innovative, where we advance knowledge in service of society"(De Villiers, 2018). The Vision 2040 and strategic framework document starts on page four with for the following statement under the strategic approach: “Vision 2040 and Strategic Framework 2019–2024 articulates the positioning of Stellenbosch University (SU) as a leading research-intensive South African university in Africa, with a global reach” (Stellenbosch University, 2000).

4.2.1.1. Simulated Research Data

The Division for Research Development (DRD) annually collects data from departments and faculties which they repackage in PDF documents as reports to deans of faculties. We used the structure (i.e. fields and data model) of the data to simulate artificial values for all the experiments reported in this thesis. This simulated data for a single year is used for analysis and representation in an interactive dashboard as KPIs on an operational level to support the core strategic theme, *Research for impact*. The detailed process is explained in Appendix C: An interactive MS Power BI™ model with Simulated Research Data.

The CRISP-DM (Cross-Industry Process for Data Mining) methodology can be followed if raw data is obtained to build a model. Brown (2015) states that the CRISP-DM methodology is the most widely-used process standard for data mining projects and is flexible enough to suit many analytic styles. It is important to follow a methodology when building a new model because the methodology will assist in asking the correct questions in the different stages, help to understanding the data, the purpose of the project and keep the end goal in mind.

The following section will evaluate the possibility of cascading of KPIs from a strategic level to an operational level in the University.

4.2.2. Vertical cascading of KPIs in the organisation

Eckerson (2009:15) refers to vertical and horizontal cascading of performance indicators in an organisation. Vertical cascading provides a line-of-sight view of performance across all groups and levels of the organisation. Vertical cascading (as discussed in the literature review on page 32) can occur in two ways: within a single performance dashboard and among performance dashboards of the same type. KPIs within a single dashboard are tightly coupled and allows for users to drill down from summary to detail-level views of performance across many dimensions. KPIs of dashboards of the same type are loosely coupled, each reflecting KPIs from a dashboard at an organisational level above it.

Horizontal cascading tries to bring together top-down initiatives that manage strategy with bottom-up dashboard projects that manage processes. Eckerson (2009:17) mentions that horizontal cascading is challenging to do because most organisations have many dashboards and scorecards that overlap and there is no guarantee that seemingly identical KPIs are defined or interpreted consistently.

We suggest the application of vertical cascading for performance indicators within Stellenbosch University.

A cascaded KPI according to Eckerson (2009:16) is often duplicated on different levels and sometimes derived from lower-level metrics. Eckerson differentiates between the following cascading KPIs: Duplicate KPIs, Derived KPIs and Conglomerate KPIs. Duplicate KPIs are KPIs duplicated at lower levels; derived KPIs are KPIs rolled up from lower-level metrics that measure the same activity in different ways; and conglomerate KPIs comprises of two lower-level KPIs.

The cascading of KPIs from a strategic to an operational level is possible for the core strategic theme, *Research for impact*. The performance indicators identified from the DRD data fields consist of descriptive statistics related to research in the university, but are not KPIs on an operational level yet. One of the characteristics of a KPI according to Eckerson (2009:9) is that a KPI measure performance against a target (see page 30 in the literature review). The simulated artificial research data does not contain any targets. The goal is to evaluate the descriptive metrics against the SMIs under the new Strategic Framework 2019-2024 and determine if some of the SMIs are derived KPIs from the descriptive metrics. Another goal is to determine if it is possible to derive targets from the SMIs to establish new KPIs on an operational level.

There are five SMIs under this theme on SU's new strategic framework (see Appendix B: Stellenbosch University's Core Strategic Themes 2019-2024 *[Source: Stellenbosch University]* page 109). Table 4.1 lists the SMIs as well as some of the suggested KPIs on an operational level for the new operational dashboard for Stellenbosch University.

The vertical cascading of performance indicators from a strategic level to an operational level will be demonstrated by using the SMI "% of academic staff members with a doctorate to all academic staff members" by duplicating KPIs on a strategic level and an operational level and deriving performance indicators from a strategic level to an operational as an example in this study.

The SMIs on the strategic framework under the core strategic theme, *Research for impact*, can be broken down with measures and KPIs on an operational level as indicated on Table 4.1.

Table 4.1: SMIs under the core strategic theme, Research for impact and some of the KPIs proposed on an operational level to support Research for impact

SMIs on the strategic framework	Descriptive statistics on an operational level
1. % of academic staff members[5] with a doctorate to all academic staff members (a/f)	a. Number of academic staff members[6] with a doctoral degree on a faculty and department level
2. % of Postdoctoral Research Fellows to all academic staff members[7] (b/f)	b. Postdoctoral Research Fellows on a faculty and department level
3. Average number of SU DHET accredited publication units per academic staff member[8] per year (c/f)	c. Research publication units on a faculty and department level
4. Average number of masters graduates per academic staff member[9] per year (d/f)	d. Masters degrees awarded on a faculty and department level
5. Average number of doctoral graduates per academic staff member[10] per year (e/f)	e. Doctoral degrees awarded on a faculty and department level
	f. Number of academic staff members[11] on a faculty and department level

[5] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

[6] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

[7] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

[8] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

[9] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

[10] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

[11] Academic staff permanently employed including fixed term contracts staff members (primary appointments).

The first SMI in the table "1. % of academic staff members with a doctorate to all academic staff members" is the sum of all academic staff members with doctoral degrees (a) divided by the sum of all academic staff members (f). (i.e. SMI 1 = a ÷ f)

The measures on the operational level support the SMI "% of academic staff members with a doctorate to all academic staff members" and the KPI "% of academic staff members with a doctorate to all academic staff members" on an operational level can be derived from the two mentioned measures in the model.

The SMI "% of academic staff members with a doctorate to all academic staff members" is thus one of the examples where the SMI is derived from two lower level metrics if only "number of academic staff members" and "academic staff members with a doctoral degree" are looked at separately. The SMI "% of academic staff members with a doctorate to all academic staff members" can also be duplicated on an operational level to provide for a strategic level performance indicator and an operational level performance indicator.

Figure 4.1 is a printed screen from the MS Power BI™ model showing the SMI "% of academic staff members with a doctorate to all academic staff members" on an operational level.

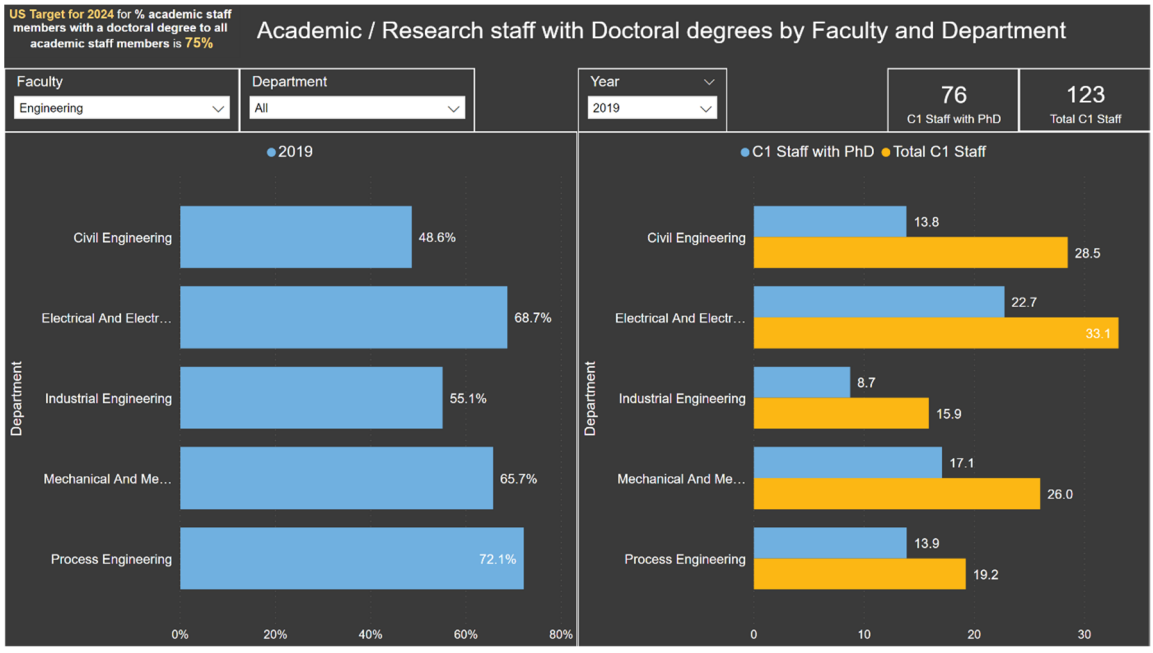

Figure 4.1: A printed screen from the MS Power BI™ model showing the '% of academic staff members with a doctorate to all academic staff members' on the left as well as the number of academic staff with doctoral degrees and all academic staff on faculty and department level on the right[12]

[12] Data fields were populated with simulated data.

The Faculty of Engineering was chosen in Figure 4.1 but the same data is available for all faculties in the university[13]. The bar chart on the left in Figure 4.1 shows the departments in the Faculty of Engineering with the percentage of academic staff members in each of the departments with a Doctoral degree. The bar chart on the right in Figure 4.1 shows two metrics, the total number academic staff members in each of the departments of the Faculty of Engineering and the total number of academic staff members with a Doctoral degree in each of the departments in the Faculty of Engineering.

The target for the SMI "% of academic staff members with a doctorate to all academic staff members" is indicated in the top left corner of Figure 4.1. The target set for the SMI "% of academic staff members with a doctorate to all academic staff members" is 75 percent for the whole university. The selection of targets for KPIs on an operational level will be addressed later in this chapter.

Staff categories at Stellenbosch University are divided into so-called C-categories. C1 refers to 'Teaching and/or Research Academic Staff'; C2 refers to 'Administrative Management Staff, Specialists (Programmers, System specialists and Librarians), Technical staff, and Administrative and Secretarial staff, and Artisans; and C3 refers to Service Workers. Figure 4.1 reference C1 Staff which refers to 'Teaching and/or Research Academic' staff members at Stellenbosch University.

The previous sections describe the creation of an operational level dashboard with operational level performance indicators that support strategic level indicators in the university. The next step is to calculate effectiveness on an operational level in the university.

Effectiveness measures will provide valuable information to decision-makers, and will provide management the ability to track progress made on the performance indicators on lower levels in the university, on faculty and department level. We suggested that it is possible to calculate effectiveness for performance indicators on an operational level.

4.2.3. Calculating effectiveness for performance indicators on an operational level

Chapter 3 explains the calculation of Effectiveness in the Score Card model for Stellenbosch University by using the composite index approach. The same principles can be used to calculate

[13] Data fields were populated with simulated data.

effectiveness for operational level performance indicators on university, faculty and department level.

The SMI "% of academic staff members with a doctorate to all academic staff members" under CST, *Research for Impact*, was selected as an example to calculate effectiveness on an operational level in the MS Power BI™ model. The SMI "% of academic staff members with a doctorate to all academic staff members" was selected to show the possibility of vertical cascading from a strategic level KPI (or SMI for Stellenbosch University) to an operational level KPI by duplicating the KPI on a strategic level and an operational level as discussed in the previous section under heading 4.2.2 and the calculation of effectiveness on a strategic level and an operational level in the university.

Figure 4.1 on page 69 shows the operational level metrics for the number of academic staff members with a Doctoral degree and the number of all academic staff members as well as the "% of academic staff members with a doctorate to all academic staff members" for the Faculty of Engineering at Stellenbosch University for the academic year 2019. Figure 4.1 also indicates the target set for the university for this SMI for 2024 which is 75%, but Stellenbosch University does not have any targets for operational level metrics and/or KPIs as yet. The difference between a metric and a KPI includes the use of targets. KPIs have targets and metrics do not. Effectiveness can also not be calculated without targets.

4.2.3.1. Targets for performance indicators on an operational level

Stellenbosch University does not have targets for any performance indicator on a faculty and department level. We therefore selected the target set for the whole university for SMI "% of academic staff members with a doctorate to all academic staff members" which is 75% and allocated the same target to all department and faculties in the university for this SMI as an example in the MS Power BI™ model. Targets can be adjusted by faculty deans, faculty managers and/or the heads of departments.

Faculty deans, faculty managers and head of departments have access to SMI targets on a university level and know their field of study better than the rest of the university and are therefore in a better position to allocate targets for KPIs on an operational level. Faculty deans, faculty managers and or head of departments can provide targets that they deem appropriate for the operational level KPIs. The model can then be updated with the targets and managers and decision-makers can then track progress made on the operational level KPIs.

Effectiveness can be calculated for operational level KPIs by following the same process as described in Chapter 3 by using the composite index. The following section discuss the calculation of effectiveness for "% of academic staff members with a doctorate to all academic staff members" for faculties and departments on an operational level in the university.

4.2.3.2. The process to calculate effectiveness for Research Publication Units

The same process were followed as describe in Chapter 3 to calculate effectiveness. There are ten faculties at Stellenbosch University as illustrated in Figure 4.2.

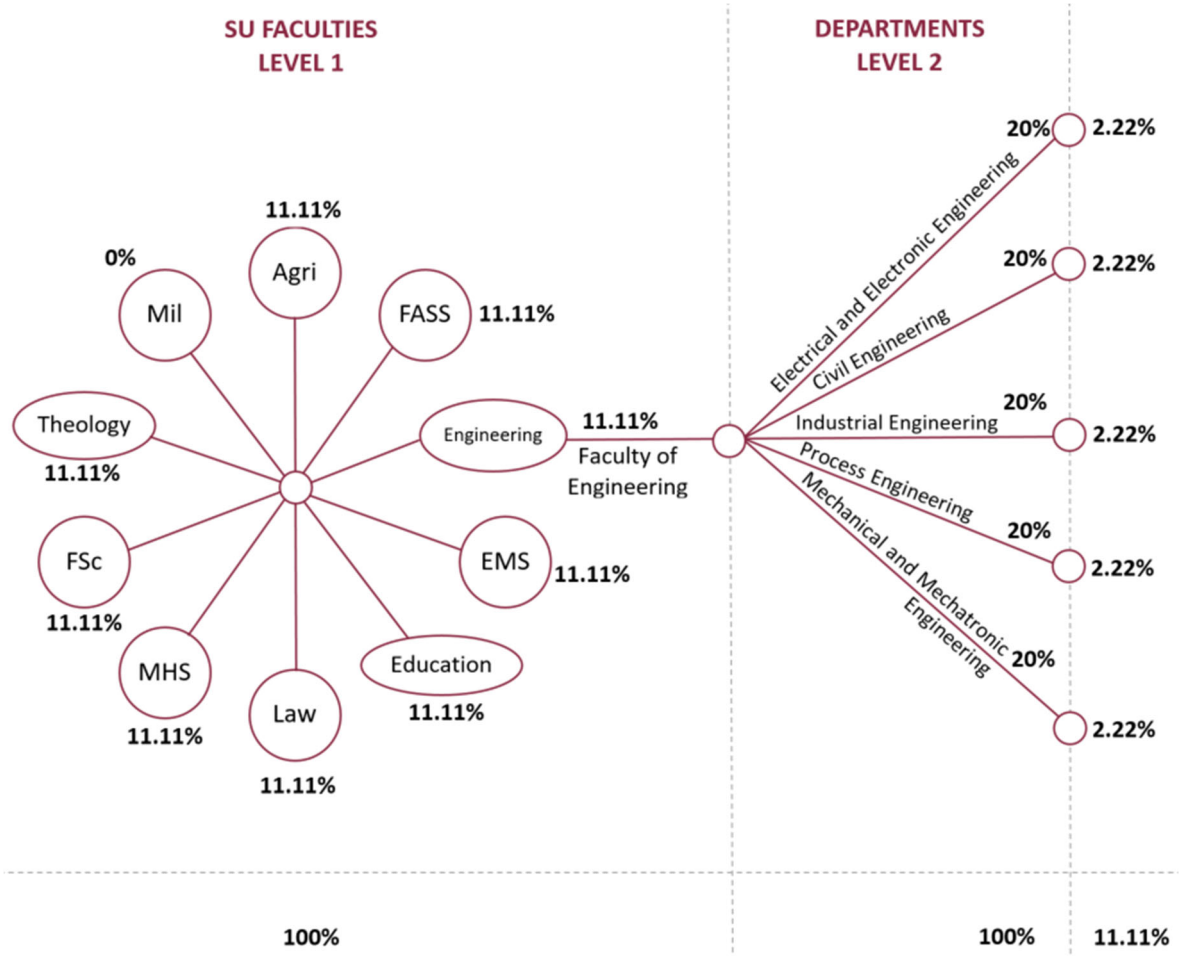

Figure 4.2: A tree diagram visually representing the weight distribution for all the faculties at Stellenbosch University on level one and the weight distribution for the Faculty of Engineering on level 2 as an example

The ten faculties indicated in Figure 4.2 include: the Faculty of AgriSciences (Agri); the Faculty of Arts and Social Sciences (FASS); the Faculty of Engineering (Engineering); the Faculty of Economic and Management Sciences (EMS); the Faculty of Education (Education);

the Faculty of Law (Law); the Faculty of Medicine and Health Sciences (MHS); the Faculty of Science (FSc); the Faculty of Theology (Theology); and the Faculty of Military Science (Mil).

Weights were equally allocated to all the faculties except for the Faculty of Military Science as illustrated on the tree on Figure 4.2. The staff data for the Faculty of Military Science are not available from Human Recourses because most of the staff from the Faculty of Military Science are not on the university's payroll and therefore excluded from the dataset. The remaining nine faculties were allocated 11.11% to add up to 100%. The Faculty of Engineering was selected as an example to indicate the further distribution of weights down the tree. The Faculty of Engineering consists of five departments and equal weights were also allocated to the five department (20% each) to add up to 100% for level 2. The weight of each department in the Faculty of Engineering then represents 2.22% of the overall university (11.11% x 20% = 2.22%) as illustrated in Figure 4.2.

Calculating the contribution of each department and faculty is crucial step in the effectiveness calculations.

The next section discuss the effectiveness calculations for the "% of academic staff members with a doctorate to all academic staff members" for the Faculty of Engineering as well as the departments of the Faculty of Engineering with the composite index approach.

4.2.3.3. Effectiveness calculations

Effectiveness is the calculation of the extent to which the target is reached as explained in Chapter 3 under section 3.1.4. Radial gauge charts were used to visualise values and targets for the faculties and departments as indicated in Figure 4.3.

Figure 4.3 is a printed screen from the MS Power BI™ model that shows the values for 2018[14] and targets for 2024 as well as the effectiveness for the Faculty of Engineering on the left and the Department of Mechanical and Mechatronic Engineering on the right as an example.

[14] Data fields were populated with simulated data.

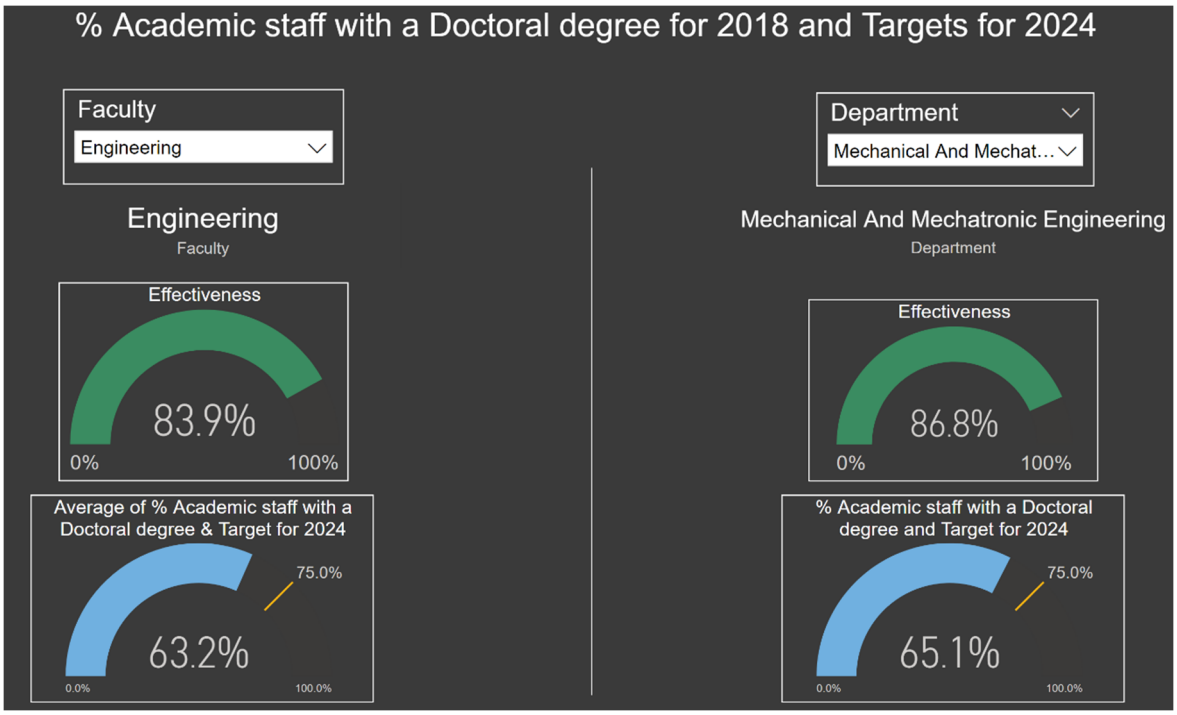

Figure 4.3: A printed screen from the model visualising performance and effectiveness for the performance indicator "% of academic staff members with a doctorate to all academic staff members" for a faculty and a department[15]

Figure 4.4 is a printed screen showing the values for 2018 and targets for 2024 for the performance indicator "% of academic staff members with a doctorate to all academic staff members" for the Faculty of Engineering and all the departments of the Faculty of Engineering.

The user has the option to select any of the faculties and then any or all of the departments within the selected faculty.

Effectiveness for the Faculty of Engineering as a whole for 2018 is 83.9% as indicated on Figure 4.4 and the Effectiveness for the Department of Mechanical and Mechatronic Engineering is 86.8% with a value of 65.1% for 2018 and the target of 75% for 2024 as indicated in Figure 4.4.[16]

[15] Data fields were populated with simulated data.

[16] Data fields were populated with simulated data.

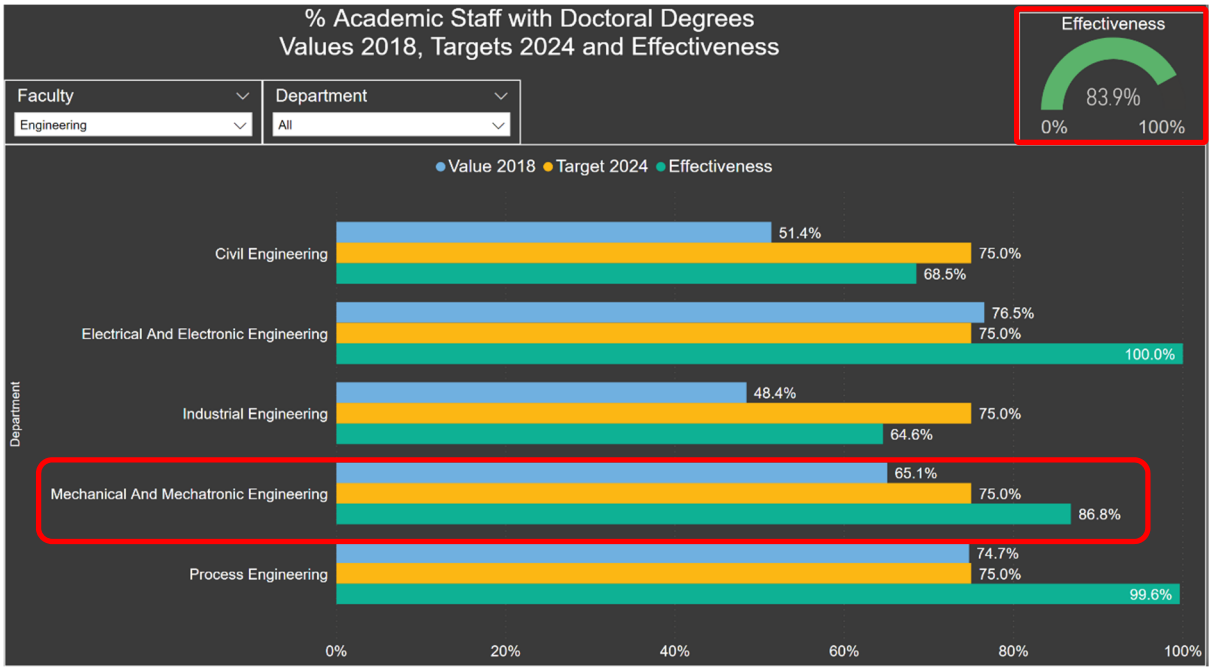

Figure 4.4: A printed screen from the model visualising the values for 2018, targets for 2024 and effectiveness calculated for the departments for the Faculty of Engineering

Effectiveness can be visualised for all faculties in the university in this model by using the composite index approach. The overall effectiveness for "% Academic staff with a Doctoral degree" can then also be calculated for the university as a whole as seen in Figure 4.5.

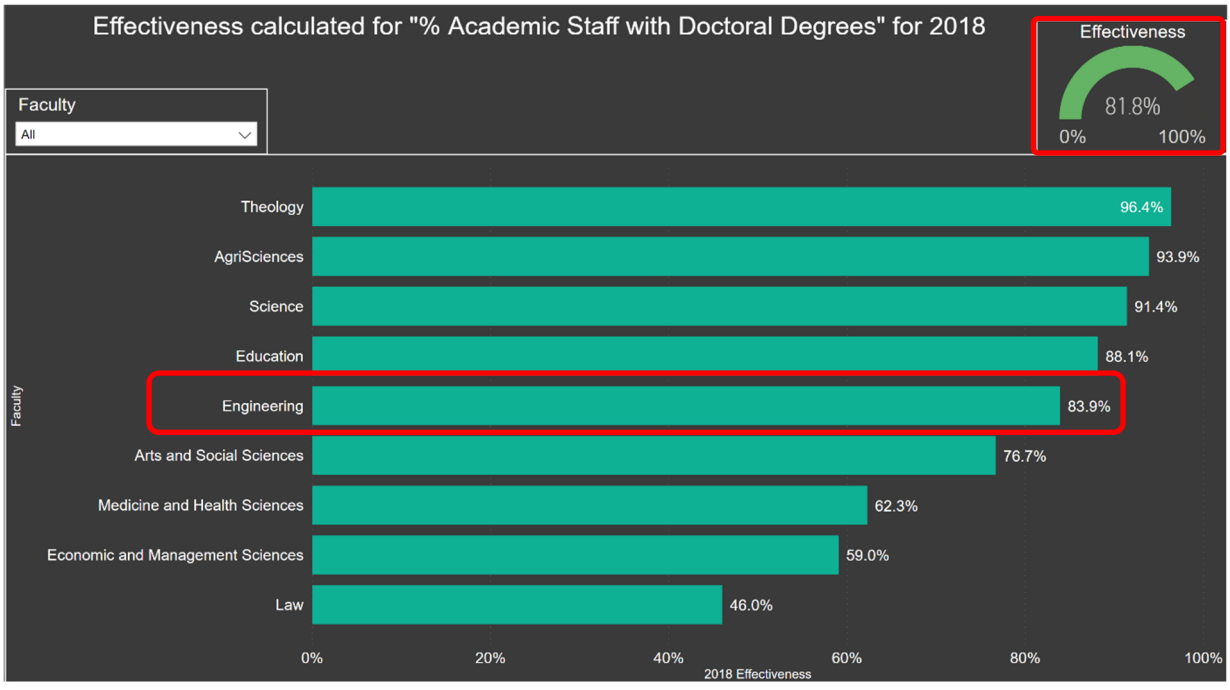

Figure 4.5: Effectiveness calculated for the nine faculties mentioned for Stellenbosch University for 2018

Figure 4.5 is a printed screen visualising effectiveness calculated for the individual faculties at Stellenbosch University with an overall effectiveness score of 81.8%. The effectiveness score for the Faculty of Engineering is 83.9% as indicated in Figure 4.5.

The SMI, "% of academic staff members with a doctorate to all academic staff members", can thus be vertically cascaded from a strategic level to an operational level by duplicating the KPI (or SMI for Stellenbosch University) from the Strategic Framework to an operational level as illustrated in Figure 4.3, Figure 4.4 and Figure 4.5.

The vertical cascading of KPIs from a strategic level to an operational level will provide management with a line-of-sight of performance across all groups and levels of the organisation.

4.3. KPIs related to research in literature

The goal of this chapter is to create a MS Power BI™ model with performance indicators on an operational level to support performance indicators under the core strategic theme, *Research for impact,* which was chosen as an example for illustrating the principles. It is important to evaluate the data collected from DRD against KPIs referenced in literature that are related to research in a university setting. DRD has not done a study (to the best of our knowledge) on KPIs listed in literature related to research. DRD collects available data annually form faculties and departments and represent the data as reports to deans in a PDF format one a year. The reports contain valuable data, but the question has not been asked if the data collected is what is needed or sufficient for management to make informative decisions. The data obtained from DRD will be evaluated in the next section against KPIs listed in literature related to research in universities.

4.3.1. Existing KPIs in the model evaluated against KPIs from literature and KPIs suggested by DRD

Table 4.2 is a list of research related KPIs found in literature, KPIs suggested from DRD, data fields obtained from DRD and data recorded in the MS Power BI™ model. Representatives from DRD were involved in 2019 in the development of indicators and measure and institutional objectives for the new Strategic Framework for Stellenbosch University 2019-2024 on a strategic level. One of the outcomes from the discussions with DRD was a list of performance indicators categorised under performance categories not taken up under the new Strategic Framework 2019-2024. The list of performance indicators was well thought through

and therefore incorporated in Table 4.2 to be evaluated against KPIs listed in literature, data fields obtained from DRD and metrics in the MS Power BI™ model (see Appendix C: An interactive MS Power BI™ model with Simulated Research Data).

Performance category in Table 4.2 refers to the groupings of performance indicators that are closely related. Performance indicators are the metrics or KPIs that are measured and evaluated for this study. The four categories listed in Table 4.2 include: (1) Literature (the following symbol ✓ indicates that the performance indicator mentioned is listed in literature); (2) Suggested by DRD (the following symbol ✓ indicates that the performance indicator was mentioned on the list received from DRD); (3) DRD data fields (the following symbol ✓ indicates that the performance indicator can be inferred from the data fields from DRD); and (4) MS Power BI™ model (the following symbol ✓ indicates that the performance indicator mentioned is recorded in the Power BI™ model developed from the data fields from DRD – see Appendix C: An interactive MS Power BI™ model with Simulated Research Data).

Table 4.2: Performance Indicators from literature that support research

Performance Category	Performance Indicator	Literature	Suggested by DRD	DRD data obtained	Power BI™ model
Research Outputs (Publications)	Number of research publications (Asif & Searcy, 2014:987) / Number of DHET publication units	✓	✓	✓	✓
	Stellenbosch University publications disaggregated by race, gender age and nationality		✓		
	Stellenbosch University research publications as a share of South African publications		✓		
	Collaboration profile (4 categories) of SA's scientific papers		✓		
	Quality of Stellenbosch University's publications as measured by JIF quartile rankings		✓		
	Per capita publication units at Stellenbosch University		✓		
	Weighted per capita knowledge output (DHET)		✓		
	ISI-refereed journals (Asif & Searcy, 2014:987) / Total Stellenbosch University articles published in WoS-journals	✓	✓		
	Non-ISI refereed Journals (Asif & Searcy, 2014:987)	✓			

Performance Category	Performance Indicator	Literature	Suggested by DRD	DRD data obtained	Power BI™ model
	Journal articles (non-refereed) (Asif & Searcy, 2014:987)	✓			
	Refereed conference paper (Asif & Searcy, 2014:987)	✓		✓	✓
	Books (Asif & Searcy, 2014:987)	✓		✓	✓
	Refereed book chapters (Asif & Searcy, 2014:987)	✓		✓	✓
	Number of monographs (Asif & Searcy, 2014:987)	✓			
	Other academic work (Asif & Searcy, 2014:987)	✓			
Research Outputs (Patents)	Number of patents (Asif & Searcy, 2014:987)	✓			
	Number of PCT patent applications		✓		
	Number of IP Filings		✓		
	The number of Spin-off companies (Asif & Searcy, 2014:987)	✓			
	Number of patents licensed and commercialized		✓		
	Number of patents addressing local needs (Asif & Searcy, 2014:987)	✓			
	The number of License agreements (Asif & Searcy, 2014:987)	✓			
The number of Strategic partnerships	The number of formal agreements the university has in research (Asif & Searcy, 2014:987)	✓			
Research projects	Number of research projects (Asif & Searcy, 2014:987)	✓			
	Number of faculty with sponsored projects (The Advisory Board Company, 2010)				
	Number of research projects addressing local needs (Asif & Searcy, 2014:987)	✓			
	Number of technology projects (Asif & Searcy, 2014:987)	✓			
	Number of spin-offs from main research stream (Asif & Searcy, 2014:987)	✓			
	The number of successful applications by National & international programs or by other sponsors (Asif & Searcy, 2014:987)	✓			
Researchers FTE	PhD Students (Wang, 2010:83)	✓			
	The annual number of doctorates conferred (Asif & Searcy, 2014:987)	✓			
	Academic staff (Wang, 2010:83)	✓			

Performance Category	Performance Indicator	Liter ature	Suggested by DRD	DRD data obtained	Power BI™ model
Research Output (Human resources)	Number of doctoral graduates (disaggregated by race, gender, age, nationality)		✓		✓
	Number of non-research and research based masters graduates		✓		✓
	Time to delivery of Masters and Doctoral graduates		✓		
Research Capacity development	R&D personnel (headcount) with a PhD		✓		✓
	R&D personnel (headcount) by gender		✓		✓
	R &D personnel (headcount) by race		✓		✓
	R&D personnel by nationality		✓		
	R&D personnel by age interval		✓		
	Number of Postdoctoral Research Fellows		✓	✓	✓
	% of faculty attending conferences and seminars (Asif & Searcy, 2014:987)	✓			
	% of faculty winning academic grants (Asif & Searcy, 2014:987)	✓			
	Number NRF Rated Researchers at SU (disaggregated by NRF rating)				✓
	National number of NRF Rated Researchers (disaggregated by NRF rating and institution)				✓
Research outcomes	Annual growth of successful entrepreneurs (Asif & Searcy, 2014:987)	✓			
	Impact score (Asif & Searcy, 2014:987)	✓			
	H index (Asif & Searcy, 2014:987)	✓			
	Field-normalised citation impact of Stellenbosch University publications (disaggregated by scientific field)		✓		
	Field-normalised citation impact of SU publications (disaggregated by scientific field)		✓		
	Proportion of SU papers in top 1%, top 5% and top 10% of world output		✓		
Membership of research council or editorship of journals	The number of board members in research council and editors in journals (Asif & Searcy, 2014:987)	✓			
Awards	NWO Spinoza Prize or others (e.g. European Science Awards) (Asif & Searcy, 2014:987)	✓			
Research ranking	Leiden ranking (Asif & Searcy, 2014:987)	✓			

Performance Category	Performance Indicator	Literature	Suggested by DRD	DRD data obtained	Power BI™ model
(Leiden ranking)					
Research impact focus areas	Relative field strength of main SU scientific fields		✓		
Research Income	External research income per faculty FTE (The Advisory Board Company, 2010)	✓			
	Third stream income expenditure on R&D		✓		
	Sources of R&D funding (internationally and nationally)		✓	✓	✓
	Research income by academic FTE and by Research-active FTE trend and by academic area. (Wang, 2010:83)	✓			
	Monetary amount of research grants (government non-competitive, government competitive and private grants) (Asif & Searcy, 2014:987)	✓			
Research Expenditure	Expenditures from grants and contracts (The Advisory Board Company, 2010)				
	Total R&D expenditures (The Advisory Board Company, 2010)	✓			
	Total externally sponsored research expenditures(The Advisory Board Company, 2010)	✓			
	Total government funded research expenditures(The Advisory Board Company, 2010)	✓			
	The number of researchers paid from private grants (Asif & Searcy, 2014:987)	✓			

Table 4.2 provides a list of performance indicators suggested by literature that universities may apply to evaluate research in their institutions. The list of performance indicators were also evaluated against performance indicators suggested by DRD and data fields obtained from DRD. The last column shows that performance indicators from the following categories were included in the MS Power BI™ model: Research Outputs (Publications); Research Outputs (Human resources); Research capacity development; and Research Income (see Appendix C: An interactive MS Power BI™ model with Simulated Research Data).

Stellenbosch University may investigate the possibility to include performance indicators from the following performance categories according to Table 4.2: patents; research projects; partnerships; research expenditure and citations.

The MS Power BI™ model was demonstrated to key stakeholders in research, development and innovation at Stellenbosch University in May 2020. The stakeholders were provided with a prototype to evaluate the model and given the opportunity to suggest any gaps or changes needed in the model. The model will be updated if possible when requests are received from stakeholders using the model.

4.3.2. The categorisation of performance indicators

Cloete (July 2019, 2020) refers to effectiveness and efficiency in operational management and performance indicators. Effectiveness refers to the degree to which objectives are achieved; the level of quality with which a task or process is carried out and without reference to cost. Efficiency refers to performing or functioning in the best possible manner with the least waste of time and effort.

Figure 4.6 illustrates the correlation between efficiency and effectiveness. (InsightSquared, 2020)

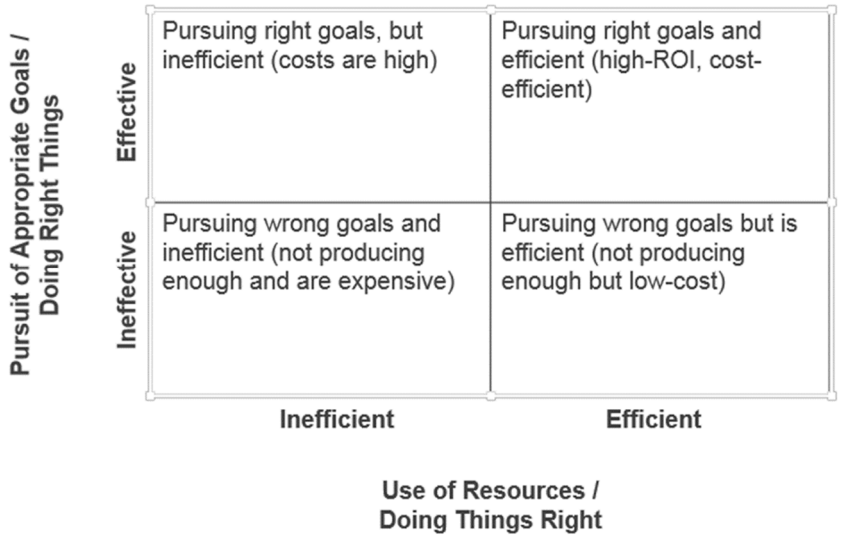

Figure 4.6: The correlation between efficiency and effectiveness (Source: InsightSquared, 2020, www.insightsquared.com/blog/effectiveness-vs-efficiency-whats-the-difference/)

Literature suggests that performance indicators according to different criteria should be included to measure performance in organisations. Steward and Carpenter-Hubin (2000:38) suggest that organisations include performance indicators intended for internal and external audiences. Ball and Wilkinson (1994:418) suggest the inclusion of internal and external performance indicators. Neely *et al*., (2007:149-150) and Eckerson (2009:11) state that

organisations should include results (or outcome or lag performance indicators) and driver (or lead) performance indicators. The different criteria are described in Chapter 2 under section 2.2.3. Cloete (2019) suggest that organisations include efficiency and effectiveness performance indicators and performance indicators should incorporate the SMARTER criteria.

Table 4.3 consist of performance categories that group performance indicators that are closely related in the first column (Performance Category) and nine categories and/or characteristics listed in literature that performance indicators can be classified or evaluated against: (1) Ouput KPIs; (2) Driver KPIs; (3) Efficiency; (4) Effectiveness; (5) performance indicators developed for External audiences; (6) performance indicators developed for Internal audiences (see page 33 for the definition); (7) Internal performance indicators (see page 33 for the definition); (8) External performance indicators; and (9) performance indicators adhering to the SMARTER criteria. The following symbol ✓ indicates if the performance indicator has the characteristic and/or can be classified according to the criteria. The last column in the table, 'Operational Dashboard,' indicates if the performance indicator occurs in the MS Power BI™ model developed from the data fields obtained from DRD (see Appendix C: An interactive MS Power BI™ model with Simulated Research Data).

Table 4.3: Performance indicators categorised according to categories in literature.

Performance Category	Performance Indicator	(1) Output PIs	(2) Driver PIs	(3) Efficiency	(4) Effectiveness	(5) External audiences	(6) Internal audiences	(7) Internal PIs	(8) External PIs	(9) SMARTER	Operational Dashboard
Research Outputs (Publications)	Number of research publications (Asif & Searcy, 2014:987) / Number of DHET publication units	✓			✓	✓			✓	✓	✓
	Stellenbosch University publications disaggregated by race, gender age and nationality	✓			✓	✓			✓	✓	
	Stellenbosch University research publications as a share of South African publications			✓			✓		✓	✓	
	Collaboration profile (4 categories) of SA's scientific papers		✓		✓		✓		✓	✓	
	Quality of Stellenbosch University's publications as measured by JIF quartile rankings	✓		✓			✓		✓	✓	

Performance Category	Performance Indicator	(1) Output PIs	(2) Driver PIs	(3) Efficiency	(4) Effectiveness	(5) External audiences	(6) Internal audiences	(7) Internal PIs	(8) External PIs	(9) SMARTER	Operational Dashboard
	Per capita publication units at Stellenbosch University	✓		✓			✓		✓	✓	
	Weighted per capita knowledge output (DHET)	✓		✓			✓		✓	✓	
	ISI-refereed journals (Asif & Searcy, 2014:987) / Total Stellenbosch University articles published in WoS-journals	✓			✓		✓		✓	✓	
	Non-ISI refereed Journals (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	Journal articles (non-refereed) (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	Refereed conference paper (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	✓
	Books (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	✓
	Refereed book chapters (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	✓
	Number of monographs (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	Other academic work (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
Research Outputs (Patents)	Number of patents (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	Number of PCT patent applications	✓			✓		✓		✓	✓	
	Number of IP Filings	✓			✓		✓		✓	✓	
	The number of Spin-off companies (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	Number of patent licensed and commercialized	✓			✓		✓		✓	✓	
	Number of patents addressing local needs (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	The number of License agreements (Asif & Searcy, 2014:987)		✓		✓		✓		✓	✓	
The number of Strategic partnerships	The number of formal agreements the university has in research (Asif & Searcy, 2014:987)		✓		✓		✓		✓	✓	
Research projects	Number of research projects (Asif & Searcy, 2014:987)		✓		✓		✓	✓	✓	✓	

Performance Category	Performance Indicator	(1) Output PIs	(2) Driver PIs	(3) Efficiency	(4) Effectiveness	(5) External audiences	(6) Internal audiences	(7) Internal PIs	(8) External PIs	(9) SMARTER	Operational Dashboard
	Number of faculty with sponsored projects (The Advisory Board Company, 2010)		✓		✓		✓	✓		✓	
	Number of research projects addressing local needs (Asif & Searcy, 2014:987)		✓		✓				✓	✓	
	Number of technology projects (Asif & Searcy, 2014:987)		✓		✓			✓		✓	
	Number of spin-offs from main research stream (Asif & Searcy, 2014:987)		✓		✓		✓	✓		✓	
	The number of successful applications by National & international programs or by other sponsors (Asif & Searcy, 2014:987)		✓		✓		✓		✓	✓	
Researchers FTE	PhD Students (Wang, 2010:83)	✓			✓		✓	✓		✓	
	The annual number of doctorates conferred (Asif & Searcy, 2014:987)	✓			✓		✓	✓		✓	
	Academic staff (Wang, 2010:83)	✓			✓		✓	✓		✓	
Research Output (Human resources)	Number of doctoral graduates (disaggregated by race, gender, age, nationality)	✓			✓		✓	✓		✓	✓
	Number of non-research and research based masters graduates	✓			✓		✓	✓		✓	✓
	Time to delivery of Masters and Doctoral graduates	✓		✓			✓	✓		✓	
Research Capacity development	R&D personnel (headcount) with a PhD	✓		✓			✓	✓		✓	✓
	R&D personnel (headcount) by gender	✓			✓		✓	✓		✓	✓
	R &D personnel (headcount) by race	✓			✓		✓	✓		✓	✓
	R&D personnel by nationality	✓			✓		✓	✓		✓	
	R&D personnel by age interval	✓			✓		✓	✓		✓	
	Number of Postdoctoral Research Fellows		✓		✓		✓	✓		✓	✓
	% of faculty attending conferences and seminars (Asif & Searcy, 2014:987)		✓		✓		✓	✓		✓	

Performance Category	Performance Indicator	(1) Output PIs	(2) Driver PIs	(3) Efficiency	(4) Effectiveness	(5) External audiences	(6) Internal audiences	(7) Internal PIs	(8) External PIs	(9) SMARTER	Operational Dashboard
	% of faculty winning academic grants (Asif & Searcy, 2014:987)		✓		✓		✓	✓		✓	
	Number NRF Rated Researchers at SU (disaggregated by NRF rating)		✓		✓		✓		✓	✓	✓
	National number of NRF Rated Researchers (disaggregated by NRF rating and institution)		✓		✓		✓		✓	✓	✓
Research outcomes	Annual growth of successful entrepreneurs (Asif & Searcy, 2014:987)		✓		✓	✓			✓	✓	
	Impact score (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	H index (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
	Field-normalised citation impact of Stellenbosch University publications (disaggregated by scientific field)	✓			✓		✓		✓	✓	
	Field-normalised citation impact of SU publications (disaggregated by scientific field)	✓			✓		✓		✓	✓	
	Proportion of SU papers in top 1%, top 5% and top 10% of world output	✓		✓			✓		✓	✓	
Membership of research council or editorship of journals	The number of board members in research council and editors in journals (Asif & Searcy, 2014:987)		✓		✓		✓		✓	✓	
Awards	NWO Spinoza Prize or others (e.g. European Science Awards) (Asif & Searcy, 2014:987)		✓		✓		✓		✓	✓	
Research ranking (Leiden ranking)	Leiden ranking (Asif & Searcy, 2014:987)	✓			✓		✓		✓	✓	
Research impact focus areas	Relative field strength of main SU scientific fields		✓		✓		✓		✓	✓	
Research Income	External research income per faculty FTE (The Advisory Board Company, 2010)	✓		✓			✓	✓		✓	
	Third stream income expenditure on R&D	✓			✓		✓	✓		✓	

Performance Category	Performance Indicator	(1) Output PIs	(2) Driver PIs	(3) Efficiency	(4) Effectiveness	(5) External audiences	(6) Internal audiences	(7) Internal PIs	(8) External PIs	(9) SMARTER	Operational Dashboard
	Sources of R&D funding (internationally and nationally)	✓			✓		✓	✓		✓	✓
	Research income by academic FTE and by Research-active FTE trend and by academic area. (Wang, 2010:83)	✓		✓			✓	✓		✓	
	Monetary amount of research grants (government non-competitive, government competitive and private grants) (Asif & Searcy, 2014:987)		✓		✓		✓	✓		✓	
Research Expenditure	Expenditures from grants and contracts (The Advisory Board Company, 2010)	✓			✓		✓	✓		✓	
	Total R&D expenditures (The Advisory Board Company, 2010)	✓			✓		✓	✓		✓	
	Total externally sponsored research expenditures (The Advisory Board Company, 2010)	✓			✓		✓	✓		✓	
	Total government funded research expenditures (The Advisory Board Company, 2010)	✓			✓		✓	✓		✓	
	The number of researchers paid from private grants (Asif & Searcy, 2014:987)	✓			✓		✓	✓		✓	

Table 4.3 evaluated nine categories listed in literature under which performance indicators can be classified. The categories include: (1) Output KPIs; (2) Driver KPIs; (3) Efficiency; (4) Effectiveness; (5) performance indicators developed for External audiences; (6) performance indicators developed for Internal audiences; (7) Internal performance indicators; (8) External performance indicators; and (9) performance indicators adhering to the SMARTER criteria. Performance indicators in the table that occur in the MS Power BI™ model developed from the data fields obtained from DRD (see Appendix C: An interactive MS Power BI™ model with Simulated Research Data) are indicated in the last column. Table 4.4 is a summary of the performance indicators according to 'Performance Category' counting the number of

performance indicators that can be classified according to the nine categories listed in Table 4.3 and explained above.

Table 4.4: Summary results from Table 4.3

Performance category	(1) Output PIs	(2) Driver PIs	(3) Efficiency	(4) Effectiveness	(5) External Audiences	(6) Internal Audiences	(7) Internal PIs	(8) External PIs	(9) SMARTER	Total	Operational Dashboard
Research Outputs (Publications)	13	1	4	11	2	13	0	15	15	74	4
Research Outputs (Patents)	6	1	0	7	0	7	0	7	7	35	0
Number of strategic partnerships	0	1	0	1	0	1	0	1	1	5	0
Research projects	0	6	0	6	0	4	4	3	6	29	0
Research FTE	3	0	0	3	0	3	3	0	3	15	0
Research Output (Human Resources)	3	0	1	2	0	3	3	0	3	15	2
Research Capacity development	5	5	1	9	0	10	8	2	10	50	6
Research Outcomes	5	1	1	5	1	5	0	6	6	30	0
Membership of research council or editorship of journals	0	1	0	1	0	1	0	1	1	5	0
Awards	0	1	0	1	0	1	0	1	1	5	0
Research ranking (Leiden ranking)	1	0	0	1	0	1	0	1	1	5	0
Research impact focus areas	0	1	0	1	0	1	0	1	1	5	0
Research Income	4	1	2	3	0	5	5	0	5	25	1
Research Expenditure	5	0	0	5	0	5	5	0	5	25	0
Total	**45**	**19**	**9**	**56**	**3**	**60**	**28**	**38**	**65**	**323**	13

Table 4.4 is a summary of the results from Table 4.3 showing the sum of the performance indicators according to the nine categories listed in the table (Output PIs; Driver PIs; Efficiency; Effectiveness; External audiences; Internal audiences; Internal PI's; External PIs; and the SMARTER criteria) combined under the fourteen performance categories from Table 4.3 [Research Outputs (Publications); Research Outputs (Patents); Number of strategic partnerships; Research projects; Research FTE; Research Output (Human Resources); Research Capacity development; Research Outcomes; Membership of research council or

editorship of journals; Awards; Research ranking (Leiden ranking); Research impact focus areas; Research Income; Research Expenditure].

Table 4.4 shows that performance indicators listed in Table 4.3 under the performance categories; Research Outputs (Publications); Research capacity development; and Research Outcomes can be classified under eight of the nine categories mentioned in literature. Performance indicators under 'Research income' adheres to seven out of the nine categories listed in Table 4.4. Performance indicators under the performance categories Research Outputs (Patents); Research projects; and Research Output (Human Resources) listed in Table 4.4 can be classified under six of the nine categories listed. The remainder of the performance categories: Number of strategic partnerships; Research FTE; Membership of research council or editorship of journals; Awards; Research Rankings; and Research Expenditure can be classified under five of the nine categories listed in Table 4.4.

Performance indicators listed in Table 4.3 and included in the MS Power BI™ model developed from the data fields obtained from DRD can be classified under eight of the nine categories: Outcome PIs; Driver PIs; Effectiveness; External audiences; External PIs; Internal audiences; Internal PIs; the SMARTER criteria. Efficiency is the only category not addressed by any of the performance indicators included in the MS Power BI™ model. There is however an Efficiency model developed at the division for Information Governance at Stellenbosch University. (Cloete, 2018) Furthermore, we can recommend to DRD to consider adding indicators for those categories where the last column element (with a zero) shows the absence of a category in the data collected on research performance.

The section above investigated performance indicators related to research and the characteristics of performance indicators mentioned in literature. Not all performance indicators are relevant for all institutions because institutions are very different from one another. Universities have to find the ideal balance of performance indicators that are relevant for their institutions and that will measurement of appropriate activities to ensure that the institutions can achieve the goals set out in the institutions vision and mission.

4.4. Summary and conclusion

The purpose of this chapter is to investigate the development of performance indicators on an operational level that will support strategic level performance indicators at Stellenbosch University. The process of moving from strategic level performance indicators to operational level performance indicators was discussed where existing performance indicators on an

operational level were evaluated, expanded and align with performance indicators on a strategic level.

The chapter started off by looking back at the previous strategic framework under section 4.1.1 and acknowledge the existence of data on a faculty and department level for some of the pervious SMIs. The study then continued by mentioning the development of the new strategic framework for Stellenbosch University under section 4.1.2. Section 4.1.3 investigated the use of strategic level performance indicators as well as operational level performance indicators and literature's view on the development of operational level performance indicators that will support strategic level performance indicators. Eckerson (2009), Zhu (2014) and Cloete (2019) are all advocates for the development of operational level performance indicators that will support strategic level performance indicators. Eckerson (2009) and Zhu (2014) refers to the cascading of strategic level KPIs to operational level KPIs.

Section 4.2 discuss the reuse of data fields obtained from DRD to be used in a model with operational level performance indicators that will support the core strategic theme, *Research for impact*. Section 4.2.2 continues by demonstrating the vertical cascading of KPIs from a strategic level to an operational level by duplicating the KPI (or SMI for Stellenbosch University) "% Academic staff with Doctoral degrees" under the core strategic theme "Research for impact" under the new strategic framework to an operational level. The performance indicator "% Academic staff with Doctoral degrees" is incorporated in the MS Power BI™ model developed from data obtained from DRD and expanded with additional data. The target set for the University for the KPI "% Academic staff with Doctoral degrees" was reused because the university does not have any targets for the performance indicator on the operational level to calculate effectiveness for the KPI on a faculty and a department level. The vertical cascading by duplicating and deriving KPIs from strategic level to an operational level is thus possible for Stellenbosch University and will provide management with a line-of-sight in the university to make informed decisions and take corrective action where needed and on the level where needed.

Section 4.3 starts by investigating performance indicators listed in literature that are related to research in university. The section continues by also looking at the characteristics listed in literature under which performance indicators can be categorised.

Performance indicators included in the MS Power BI™ model developed for operational use are from the following performance categories listed in literature: Research Outputs

(Publications); Research Outputs (Human resources); Research capacity development; and Research income. The MS Power BI™ model does not include performance indicators from the following performance categories listed in literature: patents; research projects; partnerships; research expenditure and citations.

The section continues by categorising the performance indicators according to nine characteristics listed in the literature: Output PIs; Driver PIs; Efficiency; Effectiveness; External audiences; Internal audiences; Internal PI's; External PIs; and the SMARTER criteria.

The combined performance indicators included in the MS Power BI™ model developed for operational use adheres to eight of the nine characteristics listed in literature. Only efficiency is not directly addressed by any of the performance indicators included in the MS Power BI™ model.

Performance indicators measures inputs, activities and outputs in universities on different levels. Literature suggests that performance indicators are not universal and that universities should carefully select the performance indicators that will assist in steering the university in the right direction.

Chapter 5 provides a brief overview of the study, answers the research questions set in Chapter 1 and ends with the main conclusions of the study.

Chapter 5

Conclusion

5.1. Overview of the study

Greater expectations are being placed on higher education institutions to increase performance and stay competitive in a world economy with rapid change and an intense flow of information, therefore performance management and strategic planning is thus needed for universities to survive, as stated in Chapter 1.

Stellenbosch University recently developed the new Strategic Framework 2019-2024, for which a performance measurement system will assist the university to measure progress towards the goals set under the strategic framework.

The researcher, in her position as an Institutional Research and Planning Officer in the university, was part of the discussions when the new Strategic Management Indicators were discussed with key role-players in the university. The participation in these discussions influenced the research done for this study. The research for this study ran in parallel to a work project and the outcomes were the development of a performance measurement framework that can measure effectiveness on different levels within the university and two dashboards for the university.

Performance measurement frameworks listed in literature and developed over many years indicate how complicated performance measurement is in organisations and specifically in higher education.

Performance managements according to Eckerson (2009:4) is a four-step cycle that involves the creation of strategy and plans, monitor and analyse the execution of those plans and adjust activities and objectives to achieve strategic goals. Performance measurement forms an integral part of the performance management cycle as shown in Chapter 2.

Performance is a complex concept and multifaceted because it includes elements describing both the results and the processes (activities) creating the results. Performance only makes

sense when the data from performance measures are used in decision-making, and decisions contribute to the creation or the management of performance. (Lebas & Euske, 2007:134-136)

Chapter 3 described the development of a performance measurement framework for Stellenbosch University to assist the university in measuring how far the university is successful in achieving the University's goals set out under the Strategic Framework 2019-2024. The performance measurement framework measures the university's overall performance, the performance on each of the core strategic themes as well as the strategic management indicators.

Cloete (July 2019), Cloete (2018) and Cloete (2020) suggested the utilisation of two levels of KPIs in the university, performance indicators on a strategic level to measure high-level performance and performance indicators on an operation level to measure performance on faculty and department level. The lower level performance indicators should support higher-level performance indicators as suggested by the CUC Report (2006:1).

Zhu (2014) and Eckerson (2009:13-14) suggest the use of cascading performance indicators to tie operational level metrics with strategic goals in the organisation. Chapter 4 describes the process of moving from strategic level performance indicators to operational level performance indicators, evaluate, expand and align existing performance indicators on an operational level and develop an interactive dashboard for operation level performance indicators to support one of the core strategic themes, *Research for impact* (as an example) on the strategic framework for Stellenbosch University.

5.2. Summary and discussion of main findings

5.2.1. Performance measurement at Stellenbosch University

Organisations have been struggling to find the appropriate performance measurement framework for their organisations for many years. (Neely, *et al*., 2007:144-161) Sorooshian *et al*., (2016:130) reviewed popular performance measurement systems (PMS) in literature and found that there are pros and cons for all developed PMS, but concludes that there is a lack of a comprehensive model. Parmenter (2015:299) states that the organisation should follow a methodology that is best for the organisation and sometimes it will be necessary for an organisation to use an exercise from one methodology with another methodology.

None of the mentioned performance measurement frameworks as discussed under section 2.2.2.3 can be utilised to measure performance for Stellenbosch University. The performance

measurement system that the organisation uses should relate directly to the organisation's strategy. The new strategic framework for Stellenbosch University consist of six core strategic theme, translated into goals, objectives, SMIs and KPIs (see Figure 3.1).

The composite index approach developed by Asif and Searcy (2014) is the nearest approach that we could find in literature that is similar to some aspects to the composite index approach we developed to measure performance at Stellenbosch University. The composite index approach developed by Asif and Searcy (2014) compares KPIs against peer institutions and provide ranking scores for the KPIs which are then calibrated to be incorporated into the composite index calculations, which makes this approach difficult to follow.

The effectiveness framework that we propose under section 3.3 calculates effectiveness at each level on the SU strategic framework, as well as overall effectiveness within the university without comparing our university with another university and without using any calibrations in the calculations of the composite index. Instead it shows progress towards each of the goals set in the University's Strategic Framework, and at the different levels defined within the Framework (i.e. on a University level, Core strategic theme level, Institutional objective level and Indicator and measures (SMI) level).

5.2.1.1. Composite index approach used in the Effectiveness Score Card model for Stellenbosch University

The Effectiveness Score Card is based on a composite index approach where different weights are allocated to core strategic themes, institutional objectives and indicators and measures, which all influence the overall composite effectiveness of the university.

Weights assigned to the branches on the hierarchical structure (see section 3.3.1) of the performance indicators of the strategic framework at Stellenbosch University allows for the calculation of the contribution of each performance indicator in the tree. Effectiveness in the model is the calculation of the extent to which the target of a performance indicator is reached (Value / Target) (see section 3.3.4). The framework measures the contribution of each performance indicator independently on the tree.

Composite effectiveness is calculated by using the contribution of the indicators and measures and multiplying the contribution with the effectiveness of the performance indicator. The composite index can be summarised at different levels in the university to provide different views of effectiveness at different levels. A composite index approach place performance at

the centre, facilitate communication between role players, promote accountability and highlights areas that should be a priority for improvement.

Performance indicators with no values are addressed in the model by identifying the performance indicators with no values on the different levels, then adding the contribution of the performance indicators with no values and displaying the sum of the missing values on different levels in the model (see section 3.3.6).

Composite effectiveness measures are used in the model to provide a broad picture of the performance of the university along the university's key priorities as well as to evaluate effectiveness over time.

The unique contribution of this study is the development of a composite index performance measurement approach that is based on well-defined definitions of effectiveness scores on different levels within the University's strategic framework.

The Effectiveness Score Card was discussed with and demonstrated to the rectorate on 31 March 2020 where the model was accepted as a novel management tool for Stellenbosch University.

5.2.2. Operational level KPIs to support SMIs on the University's strategic framework

Cloete (July 2019) suggests the utilisation of two levels of KPIs on a strategic level and KPIs on an operational level in the university. The previous strategic framework at Stellenbosch University consisted of sixteen strategic management indicators on a strategic level with values and targets for the university as a whole and ten strategic management indicators with values on a faculty and department level and two strategic management indicators with values on a faculty level (see Section 4.1.1)

Chapter 4 investigated the process of moving from strategic level performance indicators to operational level performance indicators in the university with reference to literature. Kaganski *et al*. (2018) and Eckerson (2009:9) state that performance indicators on an operational level should be derived from strategic level indicators and should reflect the organisation's goals and measure progress towards the achievement of these goals.

Cloete (July 2019) and Cloete (2018) suggest that a KPI (or SMI for SU) should have the ability to 'break down' and be measured on different levels in the university. Zhu (2014) and Eckerson (2009:13-14) state that KPIs cascade from higher levels to lower levels in the organisation. The

CUC Report (2006:1) suggest that high-level KPIs on a strategic level should be supported by lower level KPIs on an operational level in the institution. Zhu (2014) mentions that operational level metrics should tie directly to achieving the organisation's goals but Eckerson (2009:13-14) states that some operational metrics, even if they do not tie directly to achieving the organisation's goals, should also be included on operational dashboards. (See 4.1.3.1)

Performance indicators were investigated for the core strategic theme, *Research for impact,* as an example, on the strategic framework because we view research as one of the main goals of the University. (See section 4.2.1)

A MS Power BI™ model was developed from research data fields obtained from the Division for Research and Development and enriched with other relevant data. The prototype was presented to key stakeholders in the university and made available to track research related data. The model will be a living instrument and updated and adjusted as needed. We used the structure (i.e. fields and data model) of the data fields obtained from DRD to simulate artificial values for all the experiments reported in this thesis. The detailed process is explained in Appendix C: An interactive MS Power BI™ model with Simulated Research Data.

Operational level KPIs can be aligned with strategic level KPIs with the cascading approach from Eckerson (2009:15). KPIs can be cascaded by duplicating KPIs, deriving KPIs from other KPIs or the conglomeration of KPIs. The cascading of KPIs from a strategic level to an operational level is possible and was demonstrated in Chapter 4 by duplicating the SMI indicator "% of academic staff members with a doctorate to all academic staff members" from the strategic framework to an operational level (see section 4.2.2).

Effectiveness can be calculated for performance indicators on a strategic level as explained under section 3.3.4, as well as on an operational level as explained under section 4.2.3 with the composite index approach. Effectiveness will assist departments and faculties to track their progress towards goals set for the performance indicators. Stellenbosch University does not have targets on faculty and department level but deans of faculties, faculty managers and heads of departments have the opportunity to set goals for KPIs that they deem appropriate for their field of study.

Performance indicators from literature related to research were classified under performance categories and evaluated against the performance indicators on the operational dashboard developed from data fields obtained from DRD. Performance indicators included in the MS Power BI™ model can be categorised under the following performance categories listed in

literature: Research Outputs (Publications); Research Outputs (Human resources); Research capacity development; and Research income. The MS Power BI™ model does not include performance indicators from the following performance categories listed in literature: patents; research projects; partnerships; research expenditure and citations.

The performance indicators were also categorised according to nine characteristics listed in the literature: Output PIs; Driver PIs; Efficiency; Effectiveness; External audiences; Internal audiences; Internal PI's; External PIs; and the SMARTER criteria. The combined performance indicators included in the MS Power BI™ model developed for operational use adheres to eight of the nine characteristics listed in literature. Only efficiency is not directly addressed by any of the performance indicators included in the MS Power BI™ model.

Universities differ from each other and should therefore select the appropriate performance indicators that will assist in steering the university in the right direction.

5.3. Summary and conclusion

The major conclusions drawn or lessons learned are made explicit in this section and brought to bear on the primary and secondary research questions posed at the beginning of the study.

The two primary research questions are each stated and provided with answers where after the three secondary research questions will be stated and answered.

The first primary research question:

> *To what extent can a tailored performance measurement framework be developed to measure effectiveness at Stellenbosch University under the new Strategic Framework 2019-2024?*

A performance measurement framework was developed and modelled for Stellenbosch University. The Effectiveness Score Card model is based on a composite index approach uniquely developed for Stellenbosch University in this study. Composite effectiveness measures were created by allocating weights to performance indicators under the strategic framework according to the performance indicators' priorities. The composite index quantifies the contribution of each goal, depicted as a node in a tree relative to others and to the root node, which is the overall effectiveness score. Composite effectiveness provide a broad picture of the

performance of the university along the key dimensions of the institution as well as at lower levels. Composite effectiveness can also be evaluated over time.

The second primary research question:

> *How can strategic level performance indicators be aligned with operational level performance indicators to support the university's goals under the new strategic framework?*

Performance indicators are critical ingredients in performance management and should be derived from the institution's goals and should measure progress towards the institution's achievement of those goals. (Kaganski *et al*., 2018; Eckerson, 2009:9) Performance happens at different levels in the institution and key performance indicators link the institution's vision to individual actions.

The vertical cascading of KPIs from a strategic level to an operational level by duplicating the KPI (or SMI for Stellenbosch University) "% Academic staff with Doctoral degrees" under the core strategic theme "Research for impact" under the new strategic framework to an operational level was demonstrated in Chapter 4. The vertical cascading by duplicating and deriving KPIs from strategic level to an operational level is thus possible for Stellenbosch University and will provide management with a line-of-sight in the university to make informed decisions and take corrective action where needed.

The first secondary research question:

> *How can existing performance indicators on an operational level within the university be used to support strategic level performance indicators?*

Chapter 4 describe the process of obtaining data from the Division for Research Development. DRD annually collects research related data for faculties and department and repackage the data in reports to deans in a PDF format. The research related data contains valuable data and can be presented as performance indicators in a model to support one of the core strategic

themes under the University's strategic framework as described under sections 4.2.1.1 and 4.3.1.[17]

Section 4.2.2 list some of the descriptive statistics collected by DRD on an operational level. Two of the descriptive statistics, as an example, include: (1) Number of academic staff members with a doctoral degree on a faculty and department level, and (2) Number of academic staff members on a faculty and department level. The Strategic Management Indicator "% of academic staff members with a doctorate to all academic staff members" is the sum of all academic staff members with doctoral degrees (1) divided by the sum of all academic staff members (2). The measures collected by DRD on an operational level can thus be used on an operational level to support strategic level performance indicators by finding the derived measures on an operational level that correspond to the performance indicators on a strategic level.

The second secondary research question:

> *Are the existing performance indicators on an operational level within the university sufficient to support strategic level performance indicators according to literature?*

Performance indicators included in the MS Power BI™ model developed from data fields that were populated with simulated data are categorised under the following performance categories listed from literature: Research Outputs (Publications); Research Outputs (Human resources); Research capacity development; and Research income.

The five SMIs under the core strategic theme, *Research for impact*, which was used as an example in this thesis under the University's new Strategic Framework are all supported on an operational level within the MS Power BI™ model as demonstrated under section 4.2.2.

[17] Data fields were populated with simulated artificial data for all experiments in this thesis.

The third secondary research question:

> *How can management track progress made on operational level performance indicators within a university?*

Effectiveness can be calculated for performance indicators on an operational level as explained under section 4.2.3 with the composite index approach, which will allow management to track progress made on operational level performance indicators.

Finally, two models were developed for Stellenbosch University in this study: The Effectiveness Score Card model based on a composite index approach that tracks progress made under the university's new Strategic Framework and an operational dashboard with performance indicators on an operational level that measures performance for research in the university.

The thesis thus concludes with positive answers to the research questions that were posed.

Glossary

Term	Definition
Analytical Hierarchy Process	Analytical hierarchy process is a structured technique for organising and analysing complex decisions, based on mathematics and psychology and was developed by Thomas L. Saaty in the 1970s. (Saaty, 1987)
Balanced Scorecard (BSC)	Performance measurement tool developed by Robert S. Kaplan and David P. Norton in 1992. The BSC consist of four measurement perspectives: financial perspective, customer perspective, internal process perspective and learning and growth perspective. (Kaplan, 2010)
Driver KPIs	Driver KPIs are also known as leading KPIs that measure activities that have a significant impact on outcome KPIs. Driver KPIs measure activities in its current state and are more powerful than outcome KPIs. (Eckerson, 2009:11)
Effectiveness	"Effectiveness is doing the right things." (Peter Drucker (1986:99) "Effectiveness is the foundation of success" Peter Drucker (1986:36)
Efficiency	"Efficiency is concerned with doing things right." Peter Drucker (1986:99) "efficiency is a minimum condition for survival after success has been achieved" (1986:36)
Goal statement	A statement of a desired end-state: a state or condition that an institution or individual would like to achieve. High-level statements that typically cover multiple functions or areas of work of an institution.

	Addresses WHAT questions (what we want to achieve) and is invariably more abstract in their formulation.
Input-process-output-outcome framework	The model was developed by Brown in 1996 and assumes a linear relationship between four stages in a business process and the measures of their performance. (Neely *et al*., 2007:146-147)
Key Performance Indicators (KPIs)	KPIs tell management how the organisation is performing in their critical success factors and focus on a specific activity. (Parmenter, 2015:3-4)
Key Result Indicators (KRIs)	KRIs provide a broad overview of the overall summary of the organisation's performance. (Parmenter, 2015:3-4)
Lead (driver) indicators	Lead indicators highlight the performance of a particular issue in the organisation on the operational level. (Del-Rey-Chamorro *et al*., 2003)
Lag (outcome) indicators	Lag indicators report how well an organisation's strategy worked within a previous time period. (Del-Rey-Chamorro et al., 2003)
Outcome KPIs	Outcome KPIs are also known as lagging indicators that measure past activity. Outcome KPIs are often financial in nature but not always. (Eckerson. 2009:11)
Performance Indicators (PIs)	PIs are measures that can be linked to a team or a cluster of teams working closely together for a common purpose and focus on a specific activity. (Parmenter, 2015:3-4)
Result Indicators (RIs)	Summation of many measures of more than one group's output. RIs tell management how teams are combining to produce results of more than one activity. (Parmenter, 2015:3-4)

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Appendix A: Vision 2040

The vision statement by Stellenbosch University for 2040 (Stellenbosch University, 2020):

> *Stellenbosch University will be Africa's leading research intensive university, globally recognised as excellent, inclusive and innovative, where we advance knowledge in service of society.*

The mission statement for Stellenbosch University (Stellenbosch University, 2020):

> *Stellenbosch University is a research-intensive university where we attract outstanding students, employ talented staff and provide a world-class environment; a place connected to the world, while enriching and transforming local, continental and global communities.*

(Source: Stellenbosch University, 2020 www.sun.ac.za/english/about-us/strategic-documents)

Appendix B: Stellenbosch University's Core Strategic Themes 2019-2024 [Source: Stellenbosch University]

CORE STRATEGIC THEME 1: A THRIVING STELLENBOSCH UNIVERSITY

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
1.1	Adjust and align University funding in a broader sense	Third-stream income share of SU's recurring income (%)	Income from other government grants (excl. block grant), grants and contracts and the sale of services and products (as per Annual Financial Statements) as a % of total recurring income.	49.6%
		Fourth-stream income share of SU's recurring income (%)	Income from philanthropic donations and bequests (as per Annual Financial Statements) as a % of total recurring income.	7.0%
		Staff costs as % of total expenses	The total staff expense, as per the Annual Financial Statements, divided by the total expenses on the income statement per year.	50.0%
		Student fees due as % of student-, accommodation- and other income (Total)	Total student fees due, as per note 8 on the Annual Financial Statements, divided by the total student-, accommodation- and other income on the income statement per year.	17.0%
		Unearmarked, unrestricted reserves as of total income	Unrestricted funds are those which council uses at its own discretion. In the pool of unrestricted funds are funds which are earmarked for specific purposes and can therefore not be used for other purposes as % of SU total income.	10.0%
		Long-term investments as % of available funds	Investments held for longer than 12 months.	65.0%
		Real investment return on net long-term investments	Investment real return of listed investments only (excluding unlisted investments and loans) and excluding the Stellenbosch Trust.	6.0%
		Liquidity ratio	The ratio of current assets to current liabilities per year.	1.00

CORE STRATEGIC THEME 1: A THRIVING STELLENBOSCH UNIVERSITY

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
		Cost of Development & Alumni Division per rand raised	Expenses (Remuneration and Operational, excl. Equipment) of the Development & Alumni Division (incl. Main Budget funding) per total donations as per the Stellenbosch Trust AFS, per respective financial year.	<R0.19
1.3	Maintain and enhance world class facilities	% Maintenance and acquisition of facilities/buildings to total income	Maintenance cost (incl. buildings, equipment, grounds and sports facilities) and capital expenditure (upgrading, expansion and renovation of facilities) as a % of SU consolidated total income for the respective year.	10.40%
		% Maintenance and acquisition of equipment to total income	Maintenance cost of small equipment and furniture (academic buildings and housing) and acquisition of equipment as a % of SU consolidated total income for the respective year.	1.40%

CORE STRATEGIC THEME 2: A TRANSFORMATIVE STUDENT EXPERIENCE

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
2.4	Strengthen strategic enrolment management to enhance access, broaden participation, achieve inclusivity and maintain SU's reputation as university of choice	Throughput rate % for undergraduate bachelor students (three year duration)	The throughput rate for **undergraduate bachelor** students calculates the number of newcomer first-year undergraduate students of a specific cohort of a specific year who have graduated either within the minimum time, or up to 2 years beyond the minimum time, to the number of students in the baseline (original) enrolments of that cohort. The obtained degree could differ from the baseline degree, but both had to be an undergraduate bachelor degree. Only programmes with a duration of **three** years are considered. [e.g. 2018 = intake 2014 (3 year B-degree + 2 years)]	75.0%

CORE STRATEGIC THEME 2: A TRANSFORMATIVE STUDENT EXPERIENCE

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
		Throughput rate % for undergraduate bachelor students (four year duration)	The throughput rate for **undergraduate bachelor** students calculates the number of newcomer first-year undergraduate students of a specific cohort of a specific year who have graduated either within the minimum time, or up to 2 years beyond the minimum time, to the number of students in the baseline (original) enrolments of that cohort. The obtained degree could differ from the baseline degree, but both had to be an undergraduate bachelor degree.Only programmes with a duration of **four** years are considered. [e.g. 2018 = intake 2013 (4 year B-degree (excl. EDP) + 2 years)]	78.0%
		Throughput rate % for Master's students	The throughput rate for **Master's** students calculates the number of entering master's students of a specific cohort of a specific year who have graduated with a master's degree either within the minimum time, or up to 2 years beyond the minimum time, to the number of students in the baseline (original) enrolments of that cohort. Only programmes with a duration of one year are considered. [excl. AIMS?] [e.g. 2018 = intake 2016 + 2 years]	80.0%
		Throughput rate % for Doctorate students	The throughput rate for **Doctorate** students calculates the number of entering doctorate students of a specific cohort of a specific year who have graduated with a doctorate degree either within the minimum time, or up to 2 years beyond the minimum time, to the number of students in the baseline (original) enrolments of that cohort. Only programmes with a duration of two year are considered. [e.g. 2018 = intake 2015 + 3 years]	75.0%
		Composition of total student body (% BCIA)	For a given year, determine the number of students who are enrolled at the University on the official census date (A). Determine the total number of students from the black, coloured, Indian and Asian population groups who are enrolled at the University on the official census date (B). Calculate the measure as (B) divided by (A).	50.0%

CORE STRATEGIC THEME 2: A TRANSFORMATIVE STUDENT EXPERIENCE

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
		Student success rates (SU Total; HEMIS based)	For a given year, determine the total number of full time-equivalent (FTE) students (A). Then determine the number of full time-equivalent (FTE) degree credits (modules completed) for the same year (B). Calculate the measure as (B) divided by (A).	90.0%
		Undergraduate student success rates (SU undergraduate students only; HEMIS based)	For a given year, determine the total number of full time-equivalent (FTE) undergraduate students (A). Then determine the number of full time-equivalent (FTE) degree credits (modules completed) for the same year (B). Calculate the measure as (B) divided by (A).	90.0%
		First time first year student enrolments as % of enrolment planning targets	For a given year, determine the number of first-time entering first year student enrolments at June (A). Then determine the latest enrolment planning target for first-time entering first year students (B). Determine the difference (C) by subtracting (A) - (B). Calculate the measure as (C) divided by (B).	1.0%
		% of enrolled students with disabilities	Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which, in the presence of various barriers, may hinders their full and effective participation in society on an equal basis with others.	2.0%

CORE STRATEGIC THEME 3: PURPOSEFUL PARTNERSHIPS AND INCLUSIVE NETWORKS

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
3.2	Extend and expand our quadruple helix (government, civil society, industry and higher education partners)	% of joint publications with external co-authors to all DHET accredited publications	% of DHET accredited publications with external co-authors per year (N-1) to all DHET accredited publications of that year	65.0%
3.3	Strenghten and expand Africa partnerships as aligned with SU vision and mission	% International students of total enrolled students	Total number of international student enrolments (based on June statistics for a given year) from countries outside of South Africa (A)	18.0%

CORE STRATEGIC THEME 3: PURPOSEFUL PARTNERSHIPS AND INCLUSIVE NETWORKS

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
			divided by total number of student enrolments (B) at Stellenbosch University.	
		% International students of total enrolled undergraduate students	Total number of international undergraduate students (based on June statistics for a given year) from countries outside of South Africa (A) divided by total number of enrolled undergraduate students (B) at Stellenbosch University.	7.0%
		% International students of total enrolled postgraduate students	Total number of international postgraduate students (based on June statistics for a given year) from countries outside of South Africa (A) divided by total number of enrolled postgraduate students (B) at Stellenbosch University.	30.0%
		% Total students enrolled at SU from other African countries	Total number of student enrolments (based on June statistics for a given year) from other African countries (A) divided by total number of student enrolments (B) at Stellenbosch University.	15.0%
		Students from other African countries as % of total enrolled undergraduate students	Total number of undergraduate student enrolments (based on June statistics for a given year) from other African countries (A) divided by total number of undergraduate student enrolments (B) at Stellenbosch University.	6.0%
		Students from other African countries as % of total enrolled postgraduate students	Total number of postgraduate student enrolments (based on June statistics for a given year) from other African countries (A) divided by total number of postgraduate student enrolments (B) at Stellenbosch University.	20.0%
3.5	Increase engagement opportunities for alumni	Number of alumni hubs, clubs and special interest groups (RSA and internationally)	Number of alumni hubs, clubs and special interest groups (RSA and internationally)	25
		% of Alumni donors to all individual donors to the university	% of Alumni donors to all individual donors to the university	65.0%
		% of Donations raised from alumni to total donations received	% of Donations raised from alumni to total donations received	25.0%

CORE STRATEGIC THEME 4: NETWORKED AND COLLABORATIVE TEACHING AND LEARNING

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets

CORE STRATEGIC THEME 5: RESEARCH FOR IMPACT

NO	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
5.2	Support research staff and invest in capacity development	% of academic staff members with a doctorate to all academic staff members	% of academic staff members with the highest qualification equal to doctorate as a percentage of academic permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date in the Salaries HR group.	75.0%
		% of Postdoctoral Research Fellows to all academic staff members	% of Postdoctoral research fellows registered in a particular year as a percentage of academic permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date in the Salaries HR group.	40.0%
5.4	Increase research impact	Average number of SU DHET accredited publication units per academic staff member per year	For a given year, determine the number of SU DHET accredited publication units (A). Determine the total number of permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date (B) in the Salaries HR group. Calculate the SMI as (A) divided by (B).	2.2
		Average number of masters graduates per academic staff member per year	For a given year, determine the number of master graduates (A). Determine the total number of academic permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date (B) in the Salaries HR group. Calculate the SMI as (A) divided by (B).	1.90
		Average number of doctoral graduates per academic staff member per year	For a given year, determine the number of doctoral graduates (A). Determine the total number of academic permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date (B) in the Salaries HR group. Calculate the SMI as (A) divided by (B).	0.550

CORE STRATEGIC THEME 6: EMPLOYER OF CHOICE

No	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
6.1	Equity, transformation and promotion of personnel	% BCIA of all staff [all job levels]	For a given year, determine the total number of permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date (A) in the Salaries HR group. Determine the total number of permanently employed incl. fixed term contracts staff members (only primary appointments) from the coloured, black, Indian and Asian population groups in the Salaries HR group who are in service on the official census date (B). Calculate the SMI as (B) divided by (A).	55.5%
		% BCIA of all Doctorates (Total staff)	Determine the total number of permanently employed incl. fixed term contracts staff members (only primary appointments) on the official census date in the Salaries HR group with the highest qualification equal to doctorate (A). Determine the total number of permanently employed incl. fixed term contracts staff members (only primary appointments) from the coloured, black, Indian and Asian population groups in the Salaries HR group who are in service on the official census date (B). Calculate the SMI as (B) divided by (A).	24.70%
		% BCIA of all Doctorates (Academic staff)	Determine the total number of permanently employed incl. fixed term contracts academic only staff members (only primary appointments) on the official census date in the Salaries HR group with the highest qualification equal to doctorate (A). Determine the total number of permanently employed incl. fixed term contracts staff members (only primary appointments) from the coloured, black, Indian and Asian population groups in the Salaries HR group who are in service on the official census date (B). Calculate the SMI as (B) divided by (A).	30.0%
6.2	Implement an Employee Assistance Programme (EAP) that supports wellness of all personnel	Indicators of well-being interventions	% Employees utilising employee assistance programme (EAP) as % of total employees (permanent and contract)	30.0%

CORE STRATEGIC THEME 6: EMPLOYER OF CHOICE

No	INSTITUTIONAL OBJECTIVES	INDICATORS AND MEASURES	DEFINITION	2024 Targets
			% of Employees participating in health screening activities (Discovery and non-Discovery members) as % of total employees (permanent and contract)	70.0%
6.5	Establish SU as a learning organisation that is responsive to both individual and organisational needs	Participation rate in training and participation/awareness events (incl. electronic) specifically for SDL purposes (incl. conferences)	% of Staff participation in Training & Development programmes	60.0%

Appendix C:

An interactive MS Power BI™ model with Simulated Research Data

Introduction

At Stellenbosch University the Division for Research Development (DRD) annually collects data about departments and faculties which they repackage in PDF documents as reports to deans of faculties. The PDF documents are visually pleasing and contains valuable research related information for a single year combined into a single document per faculty broken down to department level for all departments in a faculty. However, these documents are static (i.e. no interaction is possible with the information) and it impossible to dynamically select and examine subsets and relationships among data elements.

The research related information will be of more value in an interactive MS Power BI™ model. MS Power BI™ allows for the assembling, scrutinising, and visualisation of data from across the university, giving decision-makers greater insight into the operations and performance of the university, and allows for more informed decisions based on real data. The MS Power BI™ model will be able to show trends over years, compare data across departments and faculties and show detail information similar to the data contained in the PDF documents.

This section will show the development of a MS Power BI™ model and compare the PDF data fields with the data fields presented in the MS Power BI™ model. The model will also support the core strategic theme, *Research for Impact* on the strategic framework. We populated the data fields in the model with simulated artificial data.

DRD Research-Related Information Package

The DRD provides each dean with a tailored PDF document for that faculty titled "Research-Related Information Package"[18] which contains data about: Research publication outputs, NRF rating[19], National grants, Ethics applications, Subcommittee funding, International and early career research grants, Thuthuka funding[20], Postdoctoral Fellowships, Research contracts, Masters and PhD degrees awarded and contact information as seen in Figure C.1.

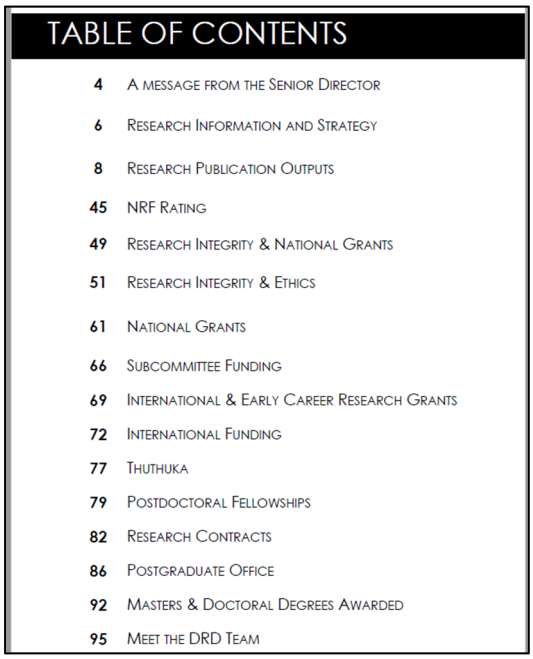

TABLE OF CONTENTS

Figure C.1: Table of Contents from the one of the DRD Research-Related Information Packages for illustrative purposes (Source: DRD, Stellenbosch University, 2020)

[18] Official consent was received from the director for Research Information and Strategy to use the DRD information pack for illustrative purposes for this study. Data fields were populated with simulated data.

[19] The NRF rating system is a benchmarking system whereby individuals who exemplify the highest standards of research, as well as those demonstrating strong potential as researchers, are identified by an extensive network of South African and international peer reviewers. Ratings are based on the quality and impact of recent research outputs (over an eight-year period). (Source: SU, www.sun.ac.za/english/research-innovation/Research-Development/research-facts/nrf-rated-scientists)

[20] The Thuthuka Funding Instrument is a key intervention of the National Research Foundation (NRF) aimed at supporting emerging researchers. Thuthuka research grants are awarded to academics and researchers that hold academic and/or joint academic and administrative professional appointments, at NRF recognised public universities, science councils and other public research institutions. (Source: NRF, www.nrf.ac.za/division/funding/thuthuka-2019)

Research related information is provided in tables in the document. Table C.1 is an example of Research Publication Outputs for a faculty per department[21].

Table C.1: Research publication outputs for a faculty.

Sum of Subsidy Units					
Department	**Chapters in Books**	**Journal Articles (subsidised)**	**Proceedings International**	**Proceedings National**	**Grand Total**
Department A	3.46	24.21	3.55		31.22
Department B	1.74	13.80	16.38	5.44	37.37
Department C		86.61	13.02	7.44	107.07
Department D		29.33	0.83	0.07	30.24
Department E	0.20	50.01	1.76		51.97
Grand Total	**5.40**	**203.97**	**35.54**	**12.95**	**257.86**

Table C.2, also from the DRD PDF is related to Research Publication Outputs for a department[22] showing Research Publication Outputs per staff member. Only part of the table is shown here for illustrative purposes.

Table C.2: Partial table showing Research Publication Output Units per staff member for a department.

Sum of Subsidy Units				
Name	**Chapters in Books**	**Journal Articles (subsidised)**	**Proceedings International**	**Grand Total**
A		0.85		0.85
B			0.17	0.17
C		0.41	0.12	1.53
D		0.43	0.59	1.02
E			0.16	0.16
F		0.42		0.42
G	0.51	0.21	1.02	1.75
H			0.04	0.04
I			0.10	0.10

[21] Faculty and department names were de-identified and the data in the table were populated with simulated data.

[22] Department names were de-identified and the data fields in the table were populated with simulated data.

The rest of the information (as indicated in the table of contents) in the PDF document follows the same layout with additional pictures and contact information of staff associated with the DRD.

An interactive MS Power BI™ model with Research Related Information

The DRD Research-Related Information Package PDF documents contain valuable research related information, but PDF documents are static and contains only a single year's information. MS Power BI™ is a visualisation software that allows for interactive data between faculties, departments, funding types and research publication types. It is easy to view trends over years, view overall university outputs or drill down to faculty, department or staff member. MS Power BI™ has an intuitive interface that makes it far more user-friendly and easy to navigate then complex spreadsheets and PDF documents.

PDF documents have to be recreated every year individually for every faculty which is time consuming. MS Power BI™ models on the other hand can be updated easily when new data becomes available.

Simulated Research Data for the MS Power BI™ model

The DRD Research-Related Information Package PDF documents consist of research publication outputs and funding information. The data fields used were populated with simulated data.

NRF rated researcher fields, Masters and Doctoral degrees awarded and academic/research staff with Doctoral and Masters Degrees were added to the datasets and the data fields were also populated with simulated data. It was decided to include NRF rated researcher data because rated researchers will relay cutting-edge skills to students and other researchers and it is therefore important to track these researchers in the university and nationally. Masters and Doctoral degrees awarded at a university is an indication of research being conducted at the university and are therefore important to keep track of. Research and research supervision can only be successful if the university has enough academic and research staff with doctoral degrees and therefore data related to academic and research staff with Doctoral and Masters Degrees are included in the model.

Figure C.2: Contents page from the MS Power BI™ modelFigure C.2 is a Printed screen from the MS Power BI™ software listing the data in the model.

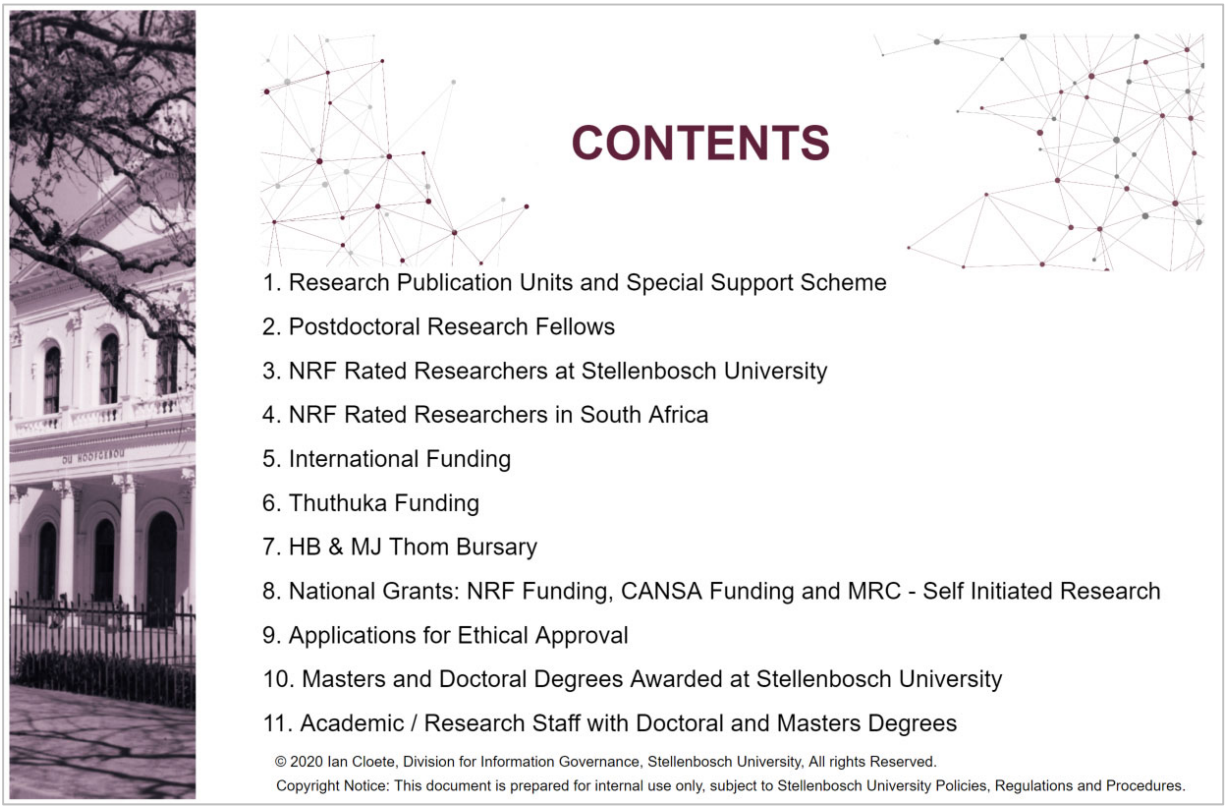

Figure C.2: Contents page from the MS Power BI™ model

123Figure C.3 is a printed screen from the MS Power BI™ model with similar data fields as the first table in the deans' reports created by DRD showing Research Publication Units for a Faculty.

The MS Power BI™ model allows for viewing of data for all the faculties, all the departments and research types by year or just a selection of the data as shown in Figure 3. The user has the option to filter by year, faculty, department and research type.

Figure C.3: A printed screen from the MS Power BI™ model showing Research Publication Units for a faculty, the departments in the faculty and research type.

Figure C.4 is another printed screen from the MS Power BI™ software model also showing Research Publication data but in a different visual presentation.

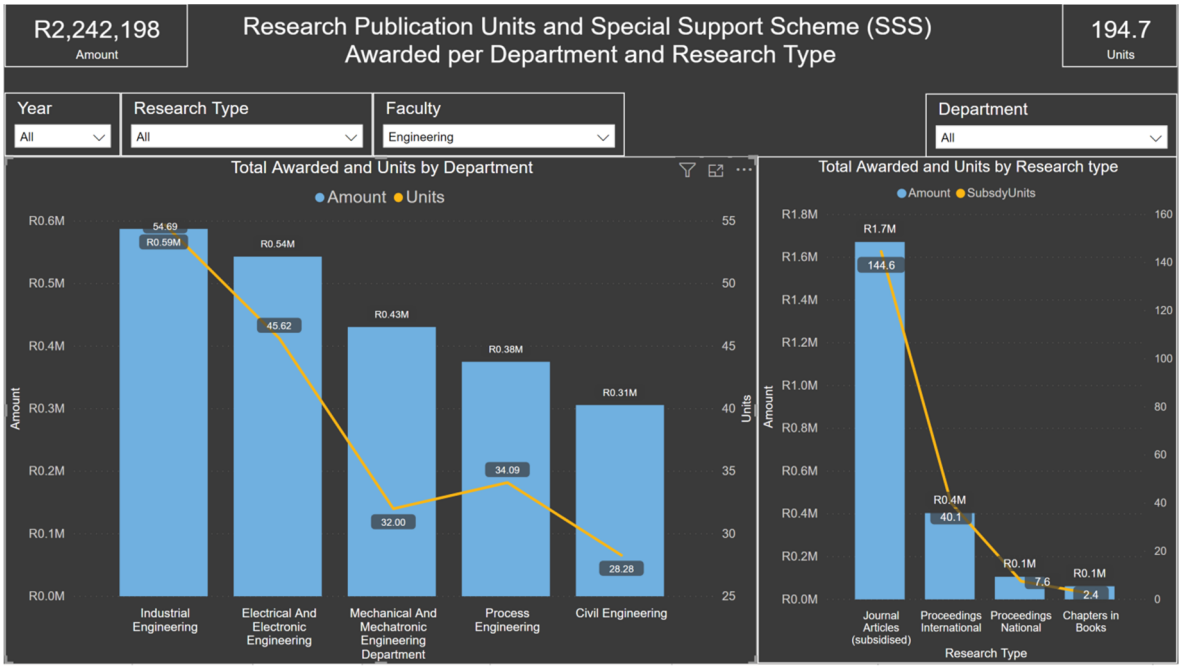

Figure C.4: A printed screen from the MS Power BI™ model showing Research Publication Units and Special Support Scheme per faculty, department and research type.[23]

[23] All data fields were populated with simulated data.

Figure C.4 shows departments on the left and research types on the right. The user has the option to select a faculty, e.g. Engineering, or more than one faculty, department and research type.

Figure C.5 is a printed screen from the MS Power BI™ model showing Research Publication Outputs for a faculty[24]. This table contains the same information as the table from the PDF document created by DRD showing Research Publication Units per staff member. The MS Power BI™ model has the added advantage that the user can filter by year, faculty, department and research type and researcher. The names listed on the printed screen were blocked out to comply with the Protection of Personal Information Act (POPIA).

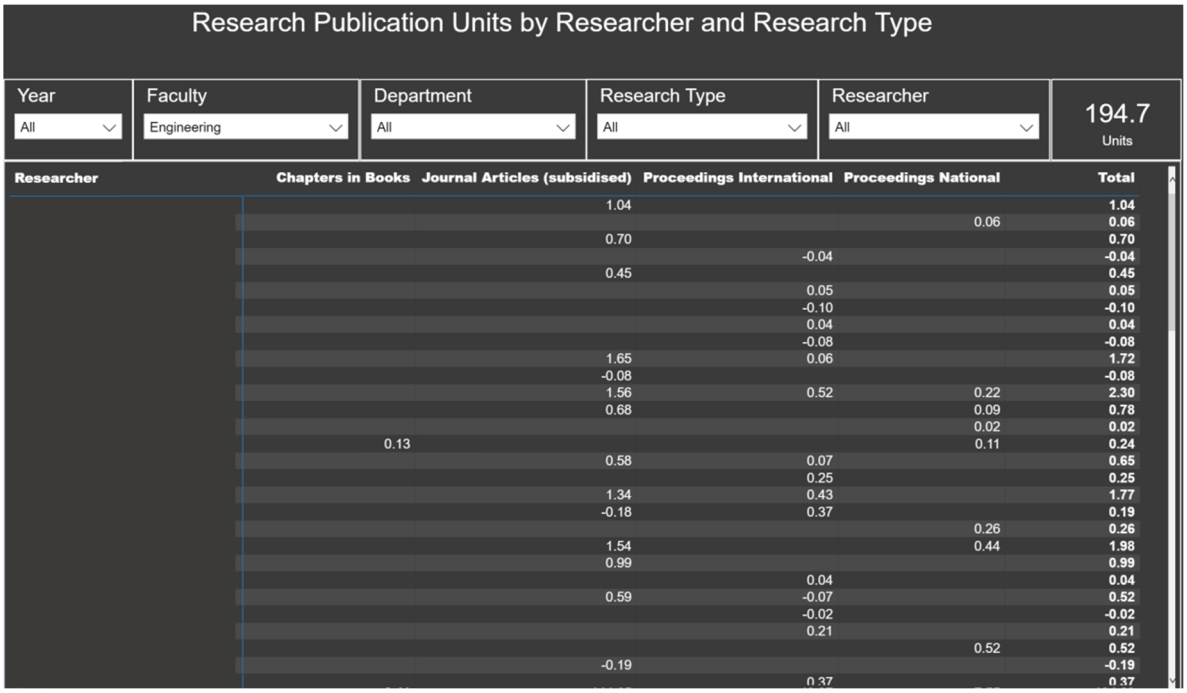

Figure C.5: A printed screen from the MS Power BI™ model showing Research Publication Units per staff member per faculty, department, research type and researcher.

Different visualisations were created in the MS Power BI™ model from the data obtained from DRD as well as the additional data obtained from other sources in the university as well as from the national NRF rated researcher website.[25]

[24] All data fields were populated with simulated data.

[25] All data fields were populated with simulated data.

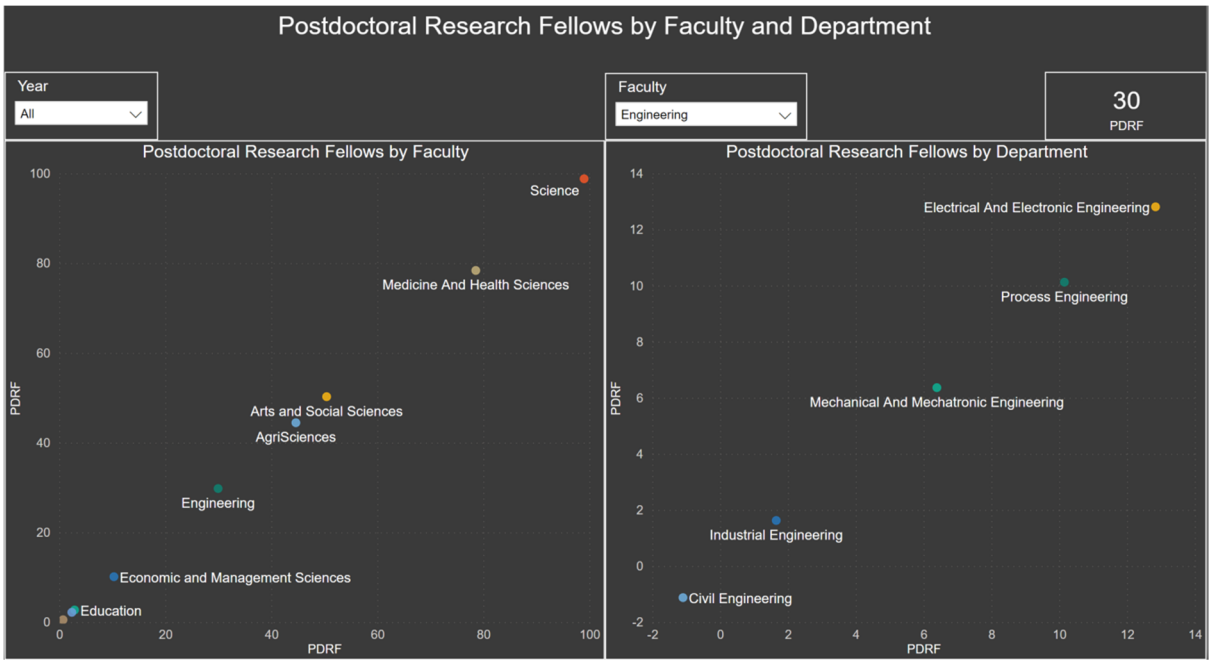

Figure C.6: A printed screen from the MS Power BI™ model showing Postdoctoral Research Fellows per faculty on the left and per department on the right.

The MS Power BI™ software has the ability to visualise data in insightful ways. Figure C.6 is a printed screen from the MS Power BI™ software showing visually where the most Postdoctoral Research Fellows[26] are situated in the university by faculty and department.

Figure C.7 is a printed screen with NRF rated researchers in South Africa[27] according to institution and NRF rating. The chart on the left shows the increasing number of NRF rated researchers in SA according to a selection of institutions. The University of Pretoria has the most NRF rated researchers in SA and Stellenbosch University the third most according to the chart on the printed screen. The bar chart on the right on the printed screen shows the composition of the NRF rated researchers according to their ratings.

[26] All data fields were populated with simulated data.

[27] The NRF Rated Researcher information is available at: https://www.nrf.ac.za/. All data fields were populated with simulated data.

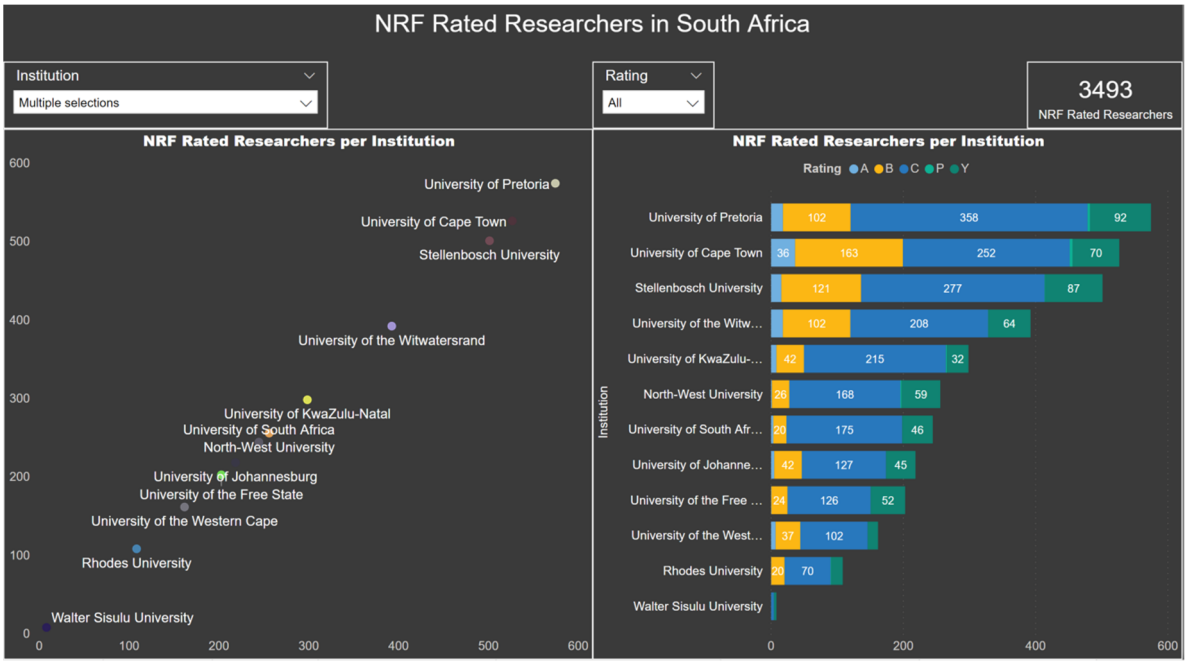

Figure C.7: A printed screen from the MS Power BI™ model showing NRF Rated Researcher per institution and rating composition.

Figure C.8 is a printed screen from MS Power BI™ that visualises the Doctoral and Masters degrees awarded by year according to race and faculty at the University[28].

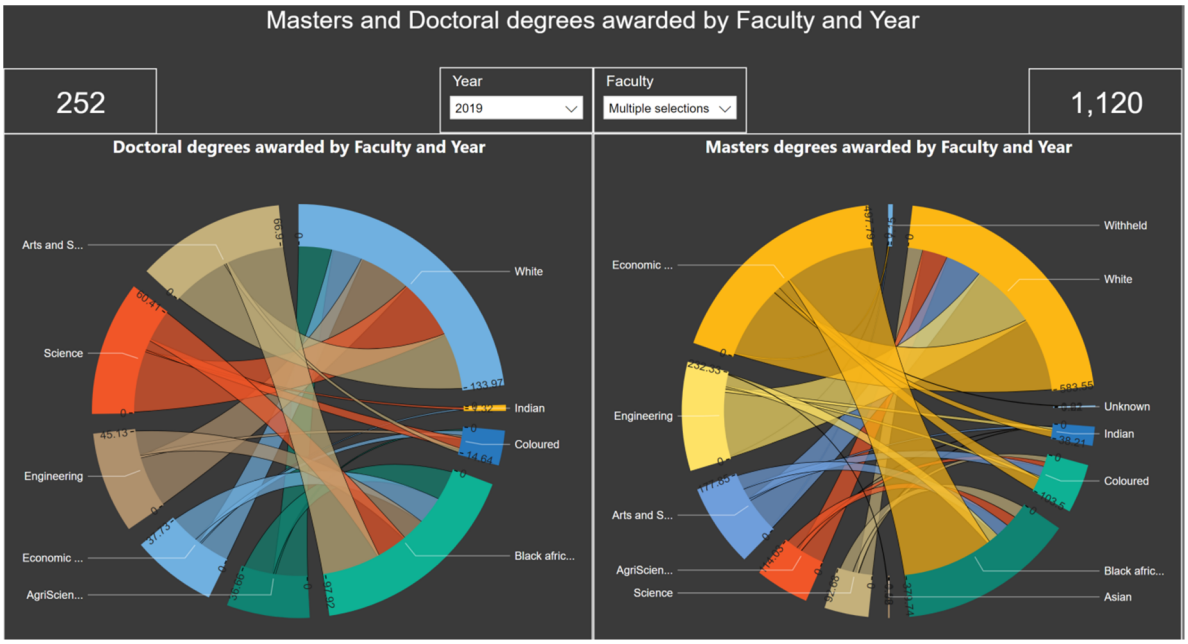

Figure C.8: A printed screen from the MS Power BI™ model showing Doctoral and Masters degrees awarded by faculty and race.

[28] All data fields were populated with simulated data.

A Chord diagram is a circular diagram that represents the relationships among a group of entities, as shown in the figure. The user has the option to select different yeas and different faculties.

Figure C.9 shows academic and research staff with doctoral degrees according to gender, race, year and faculty[29]. The charts selected for the visualisations are ribbon charts in MS Power BI™. Ribbon charts visualise data according to the highest rank or largest value. The highest range or value is always displayed on top.

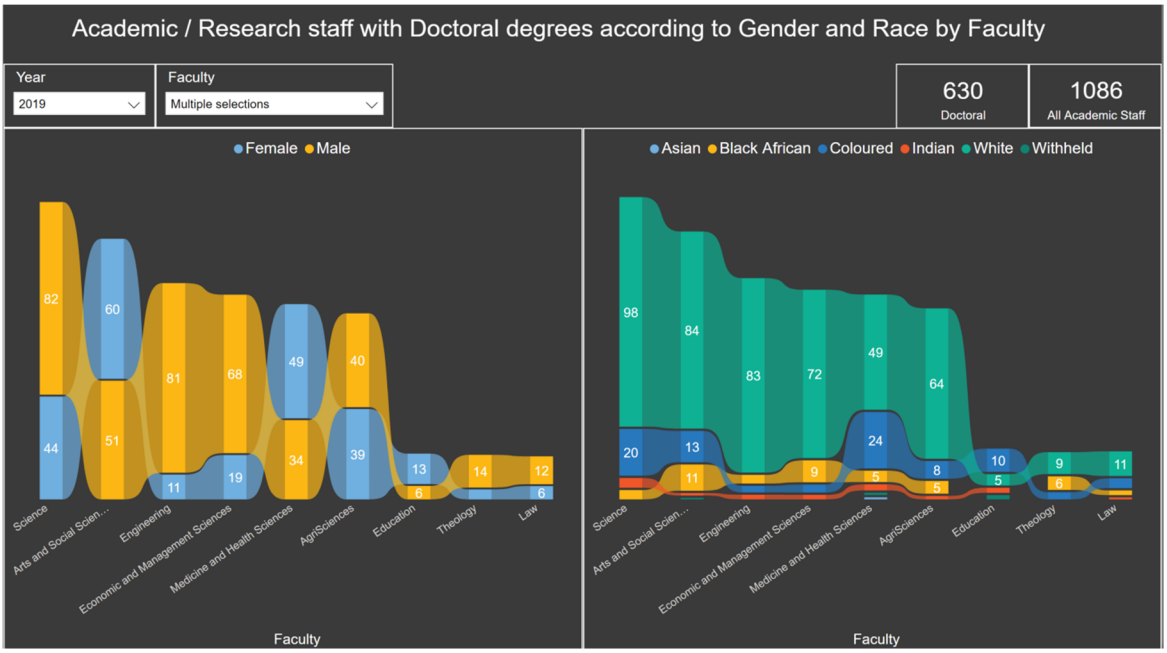

Figure C.9: A printed screen from the MS Power BI™ model showing academic staff with Doctoral degrees by faculty, gender and race.

Summary

MS Power BI™ software is a great improvement on static PDF documents. The advantage of using interactive software is that it is easy to view information across faculties, departments, ratings, funding types, research types and view trends over years. Data can be updated at any time, when data becomes available and not just annually.

An overall view of research related information of the university is available at your fingertips without scrolling through hundreds of static pages, trying to make sense of data in different tables for different entities and different years.

[29] All data fields were populated with simulated data.